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electronics

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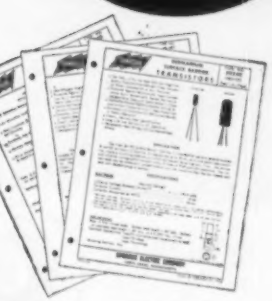

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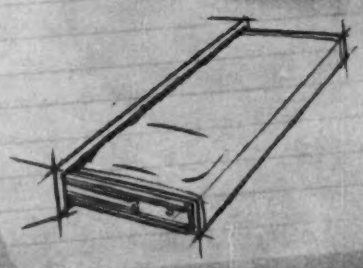

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1N66A	60	5	50 at −10
1N67A	80	4	50 at −50
1N68A	100	3	625 at −100
1N95	60	10	800 at −50
1N126	60	5	50 at −10
1N127	100	3	25 at −10

Type	Working Voltage (max.) v	Forward Current at +1 volt mA	Reverse Current μA at v
1N128	40	3	10 at −10
1N191	90	5	25 at −10
1N198	80	5†	75† at −10
1N294A	60	5	10 at −10
1N297A	80	3.5	100 at −50
1N298A	70	30*	250 at −40

*at +2 v †at 75°C

Germanium VIDEO DETECTOR Diodes

for TV video and portable radio application;
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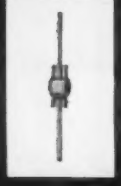
Silicon DIFFUSED JUNCTION GLASS RECTIFIERS



TYPE	Peak Operating Voltage −65°C to +150°C Volts	Ave. Rectified Current 25°C mA	Ave. Rectified Current 150°C mA	Reverse Current (Max.) in μA at Specified Voltage Volts	25°C	100°C
1N645	225	400	150	225	0.2	15
1N646	300	400	150	300	0.2	15
1N647	400	400	150	400	0.2	20
1N648	500	400	150	500	0.2	20

Silicon DIFFUSED JUNCTION RECTIFIERS

WIRE IN TYPES

TYPE	Peak Operating Voltage −65°C to +165°C Volts	Ave. Rectified Current 25°C mA	Ave. Rectified Current 150°C mA	Reverse Current (Max.) at Specified PIV, 150°C mA
1N536	50	750	250	0.40
1N537	100	750	250	0.40
1N538	200	750	250	0.30
1N539	300	750	250	0.30
1N540	400	750	250	0.30
1N1095	500	750	250	0.30
1N547†	600	750	250	0.35

† Same as 1N1096 *to +135°C

STUD TYPES

TYPE	Peak Operating Voltage −65°C to +165°C Volts	Ave. Rectified Current 25°C Amps.	Ave. Rectified Current 150°C Amps.	Reverse Current (Max.) at Specified PIV, 25°C μA
1N253	95*	3.0	1.0*	10
1N254	190*	1.5	0.4*	10
1N255	380*	1.5	0.4*	10
1N256	570*	0.95	0.2*	20
CK846	100	3.5	1.0	2
CK847	200	3.5	1.0	2
CK848	300	3.5	1.0	2
CK849	400	3.5	1.0	2
CK850	500	3.5	1.0	2
CK851	600	3.5	1.0	2

All illustrations same size. Ratings at 25°C unless otherwise indicated. 1N253 through 1N256 available to MIL Specifications.

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BUSINESS BRIEFS

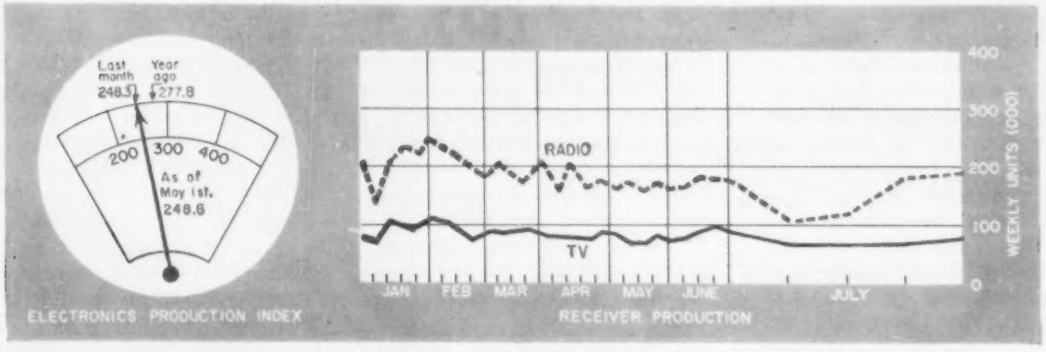
ELECTRONICS NEWSLETTER

ATLAS ICBM PRODUCTION PUSH is seen in plans to take the Titan's pure inertial guidance system and put it into Atlas. Move indicates that American Bosch Arma's pure i-g system is good enough for operational use. Contracts for Atlas' secondary system—GE's radio-inertial with Burroughs' ground-based computer system—will still be completed, however, to back-up the Atlas program. Because of the all-out Atlas effort, Titan will fall back on its secondary system—Bell Telephone Laboratories' radio-inertial—for initial flight tests. Later, Arma's pure i-g will go back into Titan. USAF says both secondary systems are satisfactory; shift to self-contained pure i-g is only to avoid electronic countermeasures.

AMERICAN SCIENTISTS IN MOSCOW for the Fifth IGY Congress said Russian data on cosmic radiation encountered by the sputniks agrees closely with findings of U.S. satellites and earlier cosmic radiation studies. McGraw-Hill World News correspondent William Coughlin, who recently arrived in Moscow, reported that two Soviet suggestions have been advanced on the origin of low energy radiation near the earth: (1) Decay of neutrons. This would result from cosmic rays slamming into the earth's atmosphere with secondary products diffusing out and neutrons decaying into protons plus electrons with a half-life of 13 minutes; (2) Electrons from the sun arrive in clouds of gas. Commenting on the similarity of this to U.S. statements, J. A. Simpson, University of Chicago physicist and cosmic radiation expert, said: "Like in zoology, we've got a new animal—we've trapped him—now we've got to find out what he is and where he came from."

NEW RESIN BINDING technique will be used in assembling the magnets for a 6 bev electron accelerator to be completed in 1960 for Harvard and MIT scientists. The $6.5 million AEC-supported machine will have a potential energy level five to six times that of previous electron accelerators. Electrons will whirl around the synchrotron for a sixtieth of a second. In that time they'll make 10,000 revolutions and get 160,000 accelerating boosts from 16 r-f cavities between the magnets. Contract for construction of the 612 magnet cores has just been announced by Baldwin-Lima-Hamilton Corp.'s Eddystone division.

FEDERAL COMMUNICATIONS COMMISSION which began vacation period this month will remain in recess until Sept. 1. To handle emergency matters, Commissioners Doerfer and Lee will be in frequent touch with their offices, and both plan to stay in or near Washington.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	July 25, '58	July 18, '58	July 26, '57
Television sets, total	60,164	56,130	123,522
Radio sets, total	173,079	161,756	234,034
Auto sets	54,653	49,771	84,394

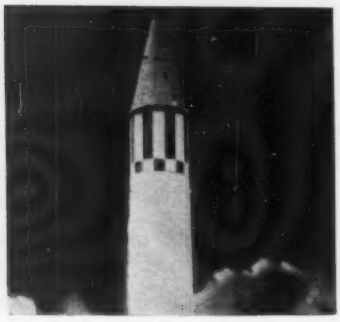
STOCK PRICE AVERAGES

(Source: Standard & Poor's)	July 30, '58	July 23, '58	July 31, '57
Radio-tv & electronics	50.59	50.43	49.23
Radio broadcasters	62.20	62.35	62.67

FIGURES OF THE YEAR

Totals for first five months

	1958	1957	Percent Change
Receiving tube sales	154,136,000	185,847,000	—17.1
Transistor production	14,894,230	8,954,000	+66.3
Cathode-ray tube sales	2,963,741	3,710,646	—20.1
Television set production	1,790,840	2,178,361	—17.8
Radio set production	4,186,869	6,098,951	—31.4
TV set sales	1,927,290	2,420,633	—20.4
Radio set sales (excl. auto)	2,307,610	2,909,548	—20.7



Infrared Scans Reentry

But it'll be a while before I-R systems are used as part of missile warning networks

Success to date of Operation Gaslight, Defense Department's project to investigate the physics of missile reentry, gives a shot in the arm to hopes for infrared systems that can detect enemy missiles at useful distances.

Gaslight makes use of radiometric and spectrographic techniques to measure the heat generated as Jupiter IRBM's reenter the atmosphere. Judging from the results of Jupiter shots in May and July, infrared technology may provide a valuable adjunct to radar in the forseeable future.

Wide-angle radiometers (picture, left) were designed especially for the Gaslight project by Barnes Engineering, Stamford, Conn. Infrared radiation at reentry is so strong that the instruments occasionally overload during the half-minute or so that the booster and nose cone are incandescent.

The radiometers are used aboard observer ships down range from Cape Canaveral, some 50 miles from the missile as it hurtles into the atmosphere at 9,000 mph. At this range, they provide more accurate indications of size and shape than radars or optical detectors do.

Infrared experts tell Electronics that current useful detection range of an infrared mosaic with an efficient optical system is "over a hundred miles." Continued improvement of transducer sensitivity and optical efficiency may double this figure. But useful data for missile detection purposes must start farther out than 300 miles.

With present components, the only answer is to get up above the earth's atmosphere where both masking background radiation and locally generated noise drop to an endurable minimum. This is one reason why the Air Force is seriously considering reconnaissance satellites as part of its missile defense plan.

Typical firing of Jupiter missile from Cape Canaveral on May 18 was picked up 1,500 miles away northeast of Antigua, B.W.I. As it reentered the atmosphere at 9,000 mph, it immediately turned white hot, "perceptibly illuminated" the observer ship, remained visible for 24 seconds, then dived into a large cumulus cloud and lit the cloud up. Brightest of the three parts of the missile (booster, instrument compartment and nose cone assembly, which is designed to protect the nuclear payload) was the booster. At one point the booster appeared to be 1,000 times brighter than the planet Jupiter, across which it flashed.

A special panoramic spectral camera analyzed visible portions of the spectrum emitted by the incandescing bodies, and motion picture cameras recorded their trajectories. The spectral camera was gyro-stabilized to reduce roll and pitch effects, used a cluster of six aerial recon cameras equipped with spectral gratings.

Navy Telecasts From 82,000 ft

Recordbreaking manned balloon flight on July 27 was highlighted by the first television broadcast from the inner fringe of space.

Primary purpose of the 34-hour overnight flight was to test the sealed cabin system which will go aloft again in November to take pictures of Mars.

Chief pilot on the flight was Cdr. Malcolm Ross of the Office of Naval Research. His copilot was Lee Lewis, head of balloon flight operations for Winzen Research, Minneapolis, which developed the gondola and the plastic Skyhook balloon. The two men broke the stratosphere endurance record of 32 hours set last fall by USAF balloonist Lt. Col. David Simons.

The balloon flight was one of ONR's Stratolab program (Electronics, p 24, Jan. 10). Besides rehearsing for the November flight and testing the gondola, the flight aimed to observe atmosphere heat-transfer characteristics, check genetic effects of stratospheric environment on insect life, study human factors, evaluate reconnaissance techniques with conventional photographic and tv equipment.

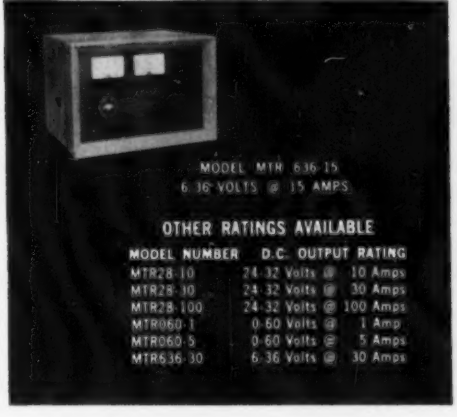
For the latter tests, the two balloonists transmitted from their peak altitude of 82,000 ft pictures of the sky, the balloon itself, the cabin's interior and each other.

Telecast used a Dage itv camera and a broadbanded radar transmitter modified for the purpose by Navy's Johnsville (Pa.) laboratories. Picture was transmitted on uhf at 475 mc on a broadbanded quarter-wave stub suspended six feet below the gondola.

Navy and Winzen Research picked up the transmission with a 12-element bedspring array at Fergus Falls, Minn. Tv station KSTP, Minneapolis, put the transmission on the air locally and was "swamped with calls," according to a Navy spokesman, asking for repeat telecasts. The picture, sent through 98 percent of earth's atmosphere and over 150 miles, was "startlingly clear."

Continued on page 12

NEED RELIABLE POWER?



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MTR060-1	0-60 Volts @ 1 Amp
MTR060-5	0-60 Volts @ 5 Amps
MTR636-30	6-36 Volts @ 30 Amps

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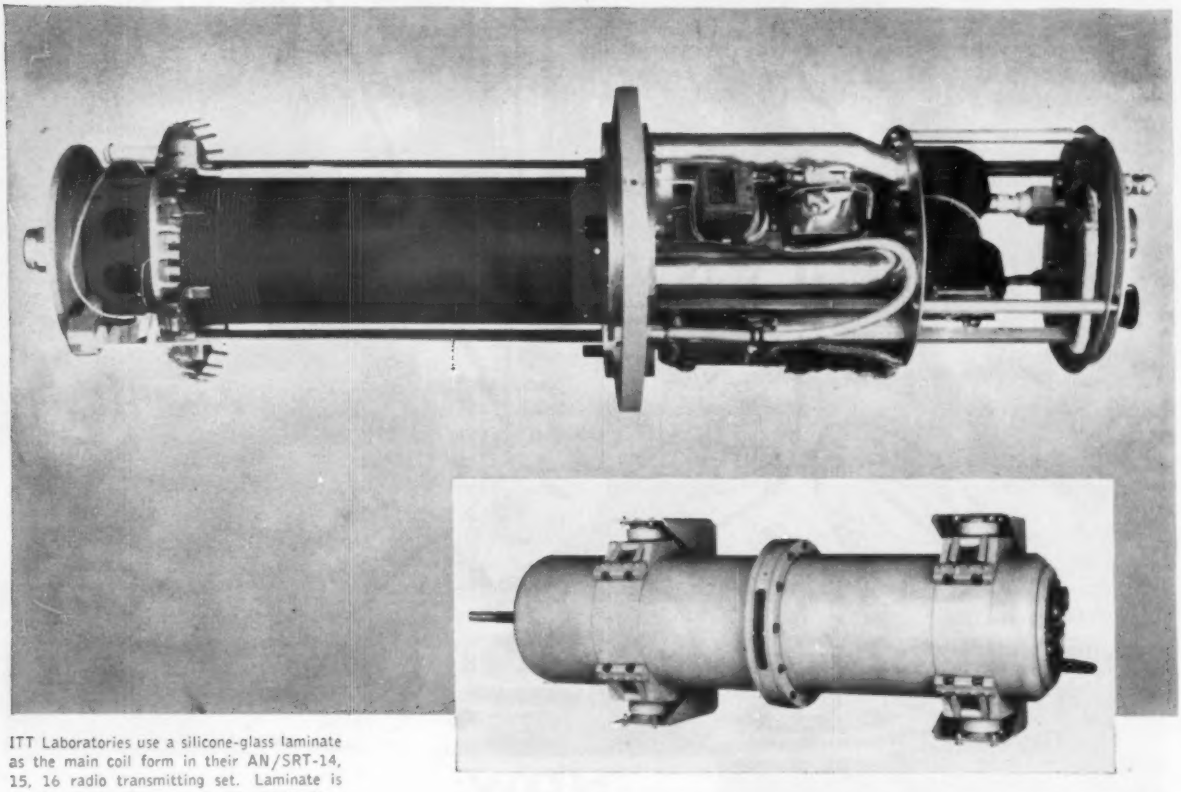


ITT Laboratories use a silicone-glass laminate as the main coil form in their AN/SRT-14, 15, 16 radio transmitting set. Laminate is tubular, 5.62" dia., wound with .064" silver wire. Primary reason for specifying silicone-glass: low loss factor at high frequencies.

TYPICAL PROPERTIES OF SILICONE GLASS-LAMINATES*

Flexural Strength, psi	
at 25C	24,000
at 260C after 100 hr at 260C	4,600
Water Absorption, percent	0.05
Electrical Strength, volts/mil	
initial	310
after 200 hr at 260C	327
after 5000 hr at 260C	180
Dielectric Constant at 10^6 cycles	
Condition A[1]	3.67
Condition D[2]	3.68
Dissipation Factor at 10^6 cycles	
Condition A[1]	.002
Condition D[2]	.004

* As measured on samples 1/8 inch thick.
[1] As received.
[2] After 24 hr immersion in water at 23C.

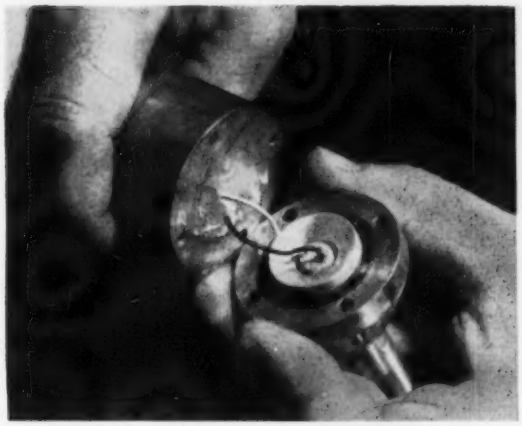
Laminates made with glass or asbestos cloth and Dow Corning silicone resins make excellent dielectric materials. These strong, lightweight laminates maintain their properties at continuous operating temperatures of 250 C . . . for short periods will withstand greater heat. Silicone-glass laminates have good mechanical strength in addition to low loss factor, low water absorption, superior resistance to arcing, corona, corrosive atmospheres and contaminants. They can be laminated in very thin sections; have fine machinability. Supplied as tubes, sheets, punched or molded shapes by leading laminators. Write for free booklet.

Visit Dow Corning's Booth No. 104 at the 1958 WESCON Show Los Angeles Pan Pacific Auditorium—Aug. 19 - 22

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

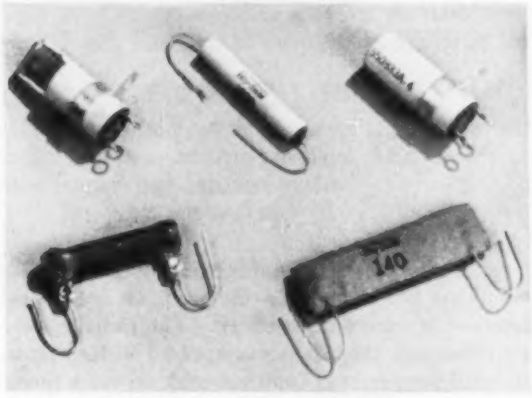
Dow Corning Silicone Dielectrics



Southwestern Industrial Electronic's S-16 Geophone

SILICONE COMPOUNDS SEAL OUT MOISTURE

Highly effective as dielectrics, Dow Corning compounds are easy to apply. They provide protection against arcs, grounds, shorts . . . improve surface resistivity. These silicone compounds retain their properties from —75 to 200 C. Employed as filling, potting, or coating materials for various types of electronic gear, they seal out moisture, increase reliability, retain their initial grease-like consistency.



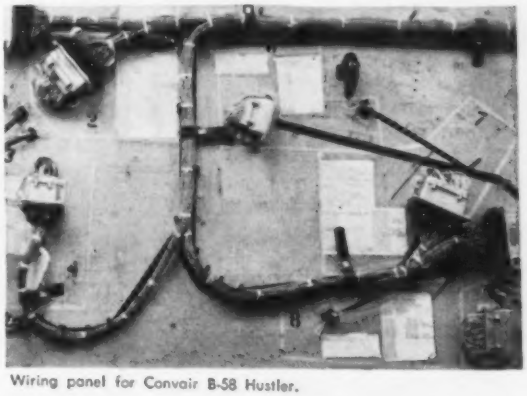
Resistors by Tru-Ohm Division of Model Engineering and Manufacturing Co.

SILICONE VARNISH MAKES IMPROVED RESISTOR CEMENT

Heat-stable and exceptionally moisture-resistant, Dow Corning varnishes make very good bonding cements. In addition, they can take fairly high loadings of inorganic fillers without loss of properties. An appropriately filled Dow Corning varnish is often far superior to conventional materials for sealing wire wound resistors and other electronic devices. Set-up time is good.

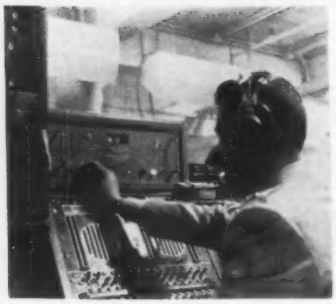
WIRE COVERING OF SILASTIC INSULATES FROM —90 to 250 C

Here is a resilient dielectric that keeps its properties from —90 to 250 C. Silastic®, the Dow Corning silicone rubber, forms a durable, moisture resistant coating for wire, cable, and other electronic and electrical components. It resists arcing, corona, ozone, weathering, corrosive atmospheres, and many fuels and solvents. Meets MIL-W-8777 specifications. Available from leading wire manufacturers.



Wiring panel for Convair B-58 Hustler.

For further information on these products write Dept. 488



Decoder Shows Plane Number

VISUAL DECODER (above) automatically identifies by number or letter specific aircraft seen only as a blip on the controller's ground radar screen.

Through use of a high-speed switching tube and a numerical indicator tube, called Nixie—capable of visually displaying either digits or letters—the innovation would end time-consuming identification of en route and approaching aircraft.

About the size of a portable radio, the unit works in conjunction with conventional radar. Employing a full 360 degrees, search and recognition radar systems establish contact with all aircraft within range and altitude of the systems.

The search radar transmits a pulse which strikes the aircraft and is reflected back to the radar receiver. The pulse's return then is displayed on a ppi scope.

Almost simultaneously, the recognition radar interrogates the airborne transponder which automatically transmits a binary-coded pulse train which has been preassigned to the aircraft. Received by the recognition radar, the pulse train is routed to the decoder.

To enable the controller to accept one binary-coded pulse train while rejecting all others, a "light gun," or electronic-eye, is placed against the face of the ppi scope over the target blip. This opens the circuit to the decoder. Thus, an aircraft can be singled out by the controller, fed to the decoder, and displayed on the numerical indicator tube.

The beam switching tube that unscrambles the transponder signal

WASHINGTON OUTLOOK

THE NATIONAL Aeronautics and Space Administration will become an important government contracting agency in electronics—for both space-related research and procurement of specialized hardware.

The new civilian space agency absorbs the 43-year-old National Advisory Committee on Aeronautics and will open shop within the next two months. Unlike NACA, which never went into electronics work extensively and had extremely limited private contracting activities, the new agency will have money to support a broad-gaged program of electronic research and development.

Among the general research fields mapped out by the new agency's planners: space communication, navigation and guidance; flight simulation; and measurement and observation techniques.

Electronics figures prominently in one specific research project NASA would like to start as quickly as possible: the development of a satellite carrying into orbit an astronomical telescope and auxiliary television equipment, to send close-up views of stars and galaxies back to earth.

According to insiders at NACA, the space agency will not build up a large staff and facilities for electronics and other new fields. Instead, the agency will rely on research and production facilities in private companies and institutions. Military-operated installations with available capacity may also be tapped for civilian space research.

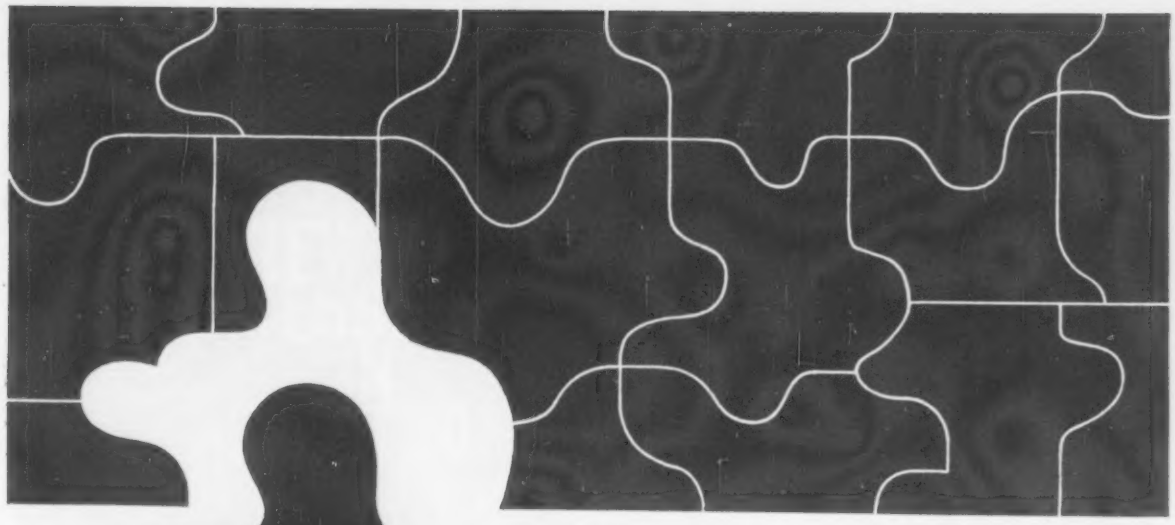
NASA is set up to plan, direct and conduct research and development in the nonmilitary phases of space—that is, basic astronautical research and development of scientific space craft. The Defense Dept., through its Advanced Research Projects Agency (which in turn farms out work to the individual services) will continue work on space projects directly tied to military requirements.

For the current fiscal year, NASA will have a budget of $289.9 million. Included is a $117-million fund to be transferred from the Pentagon's ARPA which had started nonmilitary space research pending the creation of the new agency. Examples: satellite tracking and monitoring systems and meterological reporting.

- **Success of multiplexing** on f-m channels has brought about a slow—but significant—growth in f-m broadcasting. For the first time, the Federal Communications Commission is receiving competing applications for f-m channels in certain locations.

  Three years ago, FCC permitted f-m stations to engage in certain nonbroadcast services made possible by multiplexing, services for which they could charge, at the same time they were broadcasting their regular programming to f-m home receivers. Hence, f-m stations are on the rise, with some 100 authorized for nonbroadcast services.

  Another possibility: stereophonic broadcasts. FCC approved the test—to end Oct. 31—by WBAI-FM, New York, of a compatible multiplex stereophonic system developed by Crosley.



Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?

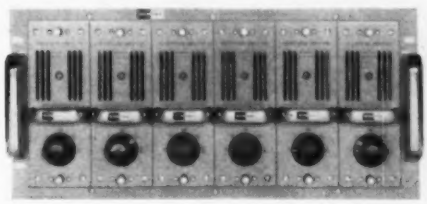
HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ .05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 120 cycle bandwidth ■ Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier . . . features that make this amplifier *really work* in instrumentation systems...features that will help solve *your* instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL – the world's largest manufacturer of precision, chopper-stabilized DC instruments.



KIN TEL 114A differential DC amplifiers ...convenient, interchangeable plug-in mounting in either 6-amplifier 19" rack mount modules or single-amplifier cabinets.

5725 Kearny Villa Road, San Diego 11, Calif.
Phone: BRowning 7-6700
Representatives in all major cities

KIN TEL
A Division of Cohu Electronics Inc.

into proper sequence for the indicator tube operates at the rate of one-millionth of a second. Capable of operating at 10 positions, the vacuum tube can be switched from one position to another in a microsecond. The indicator tube lights up within 20 to 50 millionths of a second.

The decoder was developed by Burroughs and is now undergoing final testing at ARDC's Wright Air Development Center.

Big Stereo Push Coming

CHICAGO—LAST MONTH'S convention of the National Association of Music Manufacturers here indicated that stereo is slated for considerable fall promotional activity.

Of 235 exhibitors, more than one-quarter displayed stereo equipment. One trend appears to be the "add-on" package which some manufacturers are turning out. These are packaged stereo record players including either dual-channel amplifiers with a-m/f-m tuners, or single-channel amplifiers with provisions for adding a second plug-in channel later on.

One system displayed features a transistorized low-power two-stage transmitter built into the record player. The signal of one stereo channel is converted to a-m and broadcast within the room to a conventional a-m radio for creation of the stereo effect.

A number of magnetic tape systems were displayed.

In general, convention opinion has not yet crystallized on matters of sales information. The relatively short time span during which stereo has been on the market has not been enough to allow manufacturers to determine whether this fall's sales will be heavier in one-package or building-block systems. No conclusive opinions regarding future sales of stereo conversion kits were voiced.

Meanwhile, in New York, spokesmen for tape recording firms confirmed that they are preparing for production and distribution of four-track stereo tapes this fall.

MILITARY ELECTRONICS

• **Big boost** in electronics activity will result from Republic Aviation's new $35 million R&D program. Company's new R&D center will work in three areas: high speed aircraft, missiles and space craft. Six R&D laboratories will divide their activities into space environment studies, reentry simulation and aerodynamics, materials development, guidance and control and advanced fluid systems development. One project is the study of the problems involved in sending a man to the far side of the moon and back. Next step after that, Republic's vice president Alexander Kurtveli says, will be to land a man on the moon.

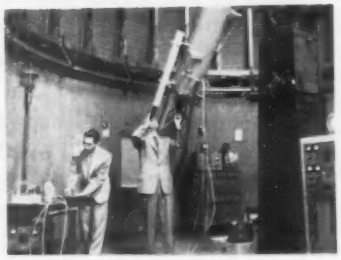
• **Federal Government** is now empowered by the new Civil Defense Aid bill to supply the states with up to $35 million a year for radiological instruments, detection devices, gas detection kits and other defense equipment.

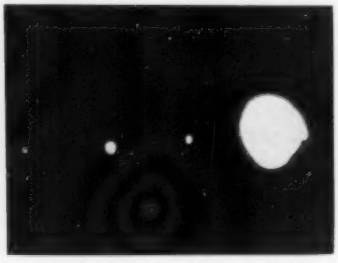
Michigan has already been granted $1.3 million to finance half the cost of a microwave radio network covering the entire state for use in case of atomic attack. Normal usage of the system will be allowed the highway dept., state police and the department of conservation. Two-way radio communications system for the highway department will also be set up.

• **Army expects** wide commercial as well as military application for its electronic earphone that shuts out noise. How noise is canceled is actually accomplished by adding more noise. Inside the earphone are two noise canceling units. One picks up the undesired outside sound. This is fed through an inverter which changes its phase 180 degrees. The inverter output then feeds a tiny loudspeaker inside the earphone to cancel the ambient noise that gets into the earphone. Low pitched sounds are trapped by special foam cushioning.

Silence synthesizers resulted from early noise reduction experiments conducted at RCA. Application of the concept to earphones was conceived by the Army.

More Uses for Cat Eye



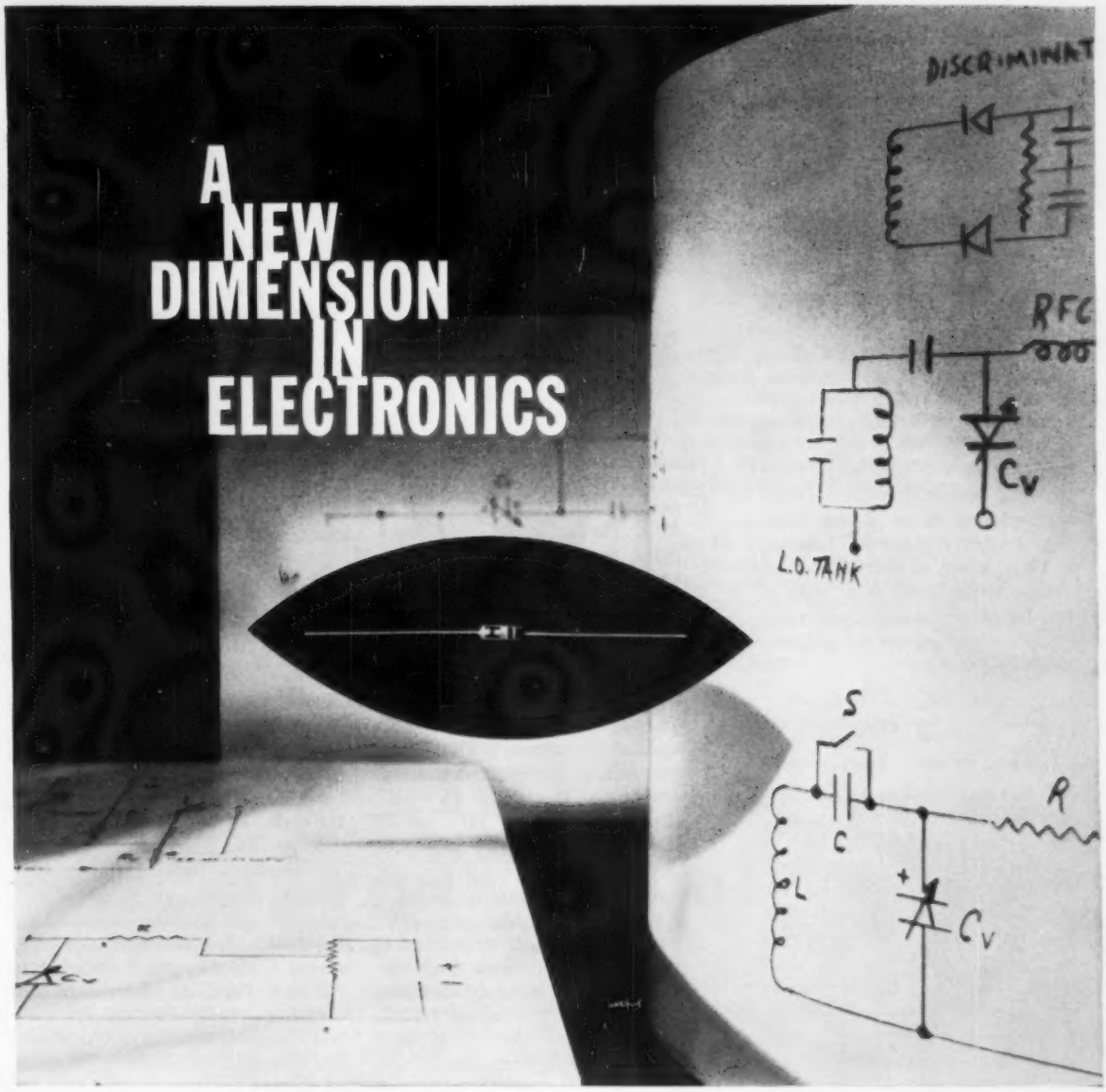


THREE MOONS of Jupiter, with a partially-obscured fourth moon at right of planet, were photographed (above) by an electronic light amplifier called Cat Eye.

Coupled with a 10-in refracting telescope, the device (shown on table above) enables Wright Air Development Command scientists to take previously impossible daytime photographs of planets and stars.

The device senses and amplifies the always present—though not always seen by the human eye—photons, packets of energy which appear as light. A transducer receives the photons and transforms the information into electrical impulses. These impulses are further amplified before reproduction on a cathode ray tube.

Besides telescopic photographs, this light amplifier has been tested for night time aerial reconnaissance. Although it works on tv-like



The Hughes silicon capacitor is a new kind of device whose full impact upon semiconductor electronics has yet to be determined. Most certainly, the silicon capacitor uncovers an entire realm of possibilities. Desirable equipment not now existing can be made for the first time. And, in every instance, bonus benefits of reduced size and weight plus greater simplicity result.

Our brochure, "The Hughes Silicon Capacitor," discusses this series and many of its applications in detail. For your copy, please write:

Hughes Products, Semiconductor Division, International Airport Station, Los Angeles 45, Calif.

WESCON Exhibits booths 1401-2.

Some Suggested Applications:

Non-Mechanical Tuning: The effect upon tuned circuit design is tremendous. Hughes silicon capacitors replace bulky air condensors and permit remote-control tuning at the end of a long wire. With these capacitors, instantaneous and non-mechanical "signal seeking" features can be designed into tuned circuits.

Automatic Frequency Controls: Here the silicon capacitors replace a reactance tube. Output voltage from the discriminator varies the voltage on the silicon capacitor—hence, the local-oscillator frequency—to correct for any frequency drift.

Dielectric Amplifiers: Operation is based on the amplitude modulation of a high-frequency carrier source by a Hughes silicon capacitor, and on the subsequent demodulation and filtering at the output.

Also: Pulse Circuits, Frequency Modulation, RC Oscillators, Modulators, Electronically Controlled Filters.

Creating a new world with ELECTRONICS

HUGHES
SEMICONDUCTORS

HUGHES PRODUCTS

© 1958, Hughes Aircraft Company

principles, the optical amplifier is about 1,000 times more sensitive than a conventional tv camera.

Westinghouse and RCA have both worked on light transducers, according to ARDC.

Waveguides Form Ship-Radar Lens

DETAILS of Britain's giant ship-borne Type 984 radar-computer system for detecting targets and directing fire were revealed by Fleet Admiral Mountbatten at the summer meeting of the British Institute of Radio Engineers in London.

Though cost of the 984 was not given, Mountbatten did make a comparison of the cost of electronic equipment in ships of the 1938 era and those of today:

	1938	1958
Frigate/ Destroyer	$11,200	$336,000-$420,000
Cruiser	$56,000	$1,440,000
Aircraft carrier	$33,600	over $2,800,000

Now in operation on Britian's aircraft carrier *H.M.S. Victorious*, eye part of the 984 is a revolving stabilized microwave lens weighing 30¼ tons, made up of hundreds of short sections of different length waveguides stacked together like a honeycomb.

The lens, which has an *F* value of 1, sends out a number of narrow pencil beams. One of these is fixed in elevation and provides the long range warning while the others make a coordinated scan of various sections of the target area as the rotating structure revolves.

The radar antenna unit sends impulses to an electronic computer system in the superstructure of the ship. An elaborate display system processes, stores and filters the information so that it can be displayed in an easily intelligible form. Range, height, bearing, speed and course are all provided and presented for easy use by a system of electronic writing. Numbers and symbols required for identifying targets and for other purposes are written electronically on the display tubes themselves. This is achieved by a combination of different waveforms to produce Lissajous characters of the required shape.

An intercept computer works out for the control officer a presentation of where and when his fighters will intercept or miss their targets if they continue on his present directions, which were also computed for him.

The equipment uses about 10,000 tubes, 100,000 other components and 250,000 soldered joints, with 275 slip rings providing connections to the revolving structure. Marconi is responsible for the modulator, transmitter and accompanying indicator circuitry.

FINANCIAL ROUNDUP

• **Acoustica Associates, Mineola, N. Y.,** acquires **General Ultrasonics** of Hartford, Conn., through exchange of stock. The Mineola firm gave 25,872 shares of its common stock in payment for all outstanding General Ultrasonics stock. Acoustica stock was recently traded in over-the-counter markets at about $10. General Ultrasonics will be operated as an Acoustica subsidiary under present management. The combined firm now employs 250 and expects to increase this number to 400 by end of 1958. The merger combines Acoustica's marketing and production facilities in the ultrasonic field with GU's research and development abilities.

• **Victoreen Instrument,** Cleveland, Ohio, authorizes redemption on August 20 of $100,000 face amount of company's $700,000 of outstanding 6-percent convertible debentures, due Nov. 15, 1967. Redemption price is $105 per debenture plus interest to August 20. Debentures are convertible into common stock at price of $3.33 per share until Nov. 15, 1962. Stock was recently traded at 4⅜ on the American Stock Exchange. Debentures were being quoted at 133 bid and 136 asked on the over-the-counter market at press time. Cleveland firm manufactures radiation instruments and electronic components.

• **Hupp Corporation,** Cleveland, Ohio, sells its electronics division which produced quartz crystals, cadmium sulfide cells and electronic switching devices at plants located at Forest Park, Ill., and Carlisle, Pa. "Profit potentials did not justify the capital expenditures necessary to expand to the level necessary for profitable operations," explains Don H. Gearhart, president of Hupp. The newly incorporated Piezo Crystal Company of Carlisle, Pa., purchased the Carlisle factory. As this issue went to press, no information was available on disposition of the Forest Park plant.

• **Advance Industries,** Cambridge, Mass., purchases all outstanding stock of **Electrolizing Corp. of Rhode Island** and its six subsidiary and affiliated companies for cash and other considerations. The acquired firm and its corporate family is engaged in special process treating of metals and ceramics, and bonding of ceramics to plastics. The missile-aircraft industry is an important customer. Advance Industries manufactures ultrasonic equipment, electronic and electrical automation controls and computer equipment.

Audio Will Star At British Show

BRITAIN'S Radio Industry Council will hold its 25th National Radio Show at Earls Court, London, from August 27 to September 6.

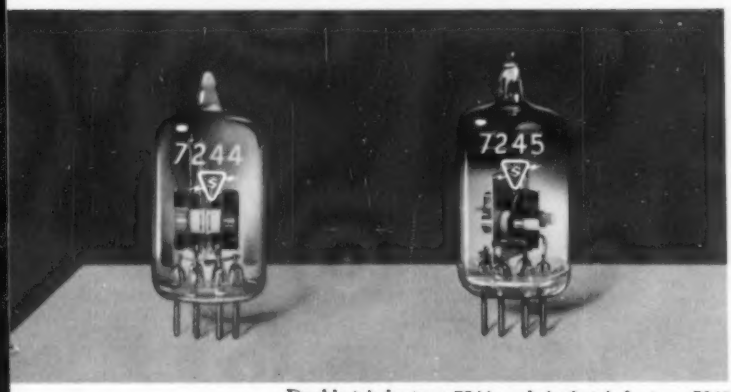
Audio equipment will have a hall to itself, with some 45 firms demonstrating their gear in soundproof rooms. Exhibits and demonstrations will include microphones, speakers, amplifiers, phonograph components, disk and tape recorders. Audio gear accounts for 20 percent of Britain's radio exports

CIRCLE 10 READERS SERVICE CARD→

Electron Tube News
—from SYLVANIA

Pioneering new concepts—Everywhere in electronics

IN BASIC TUBE DESIGN . . .

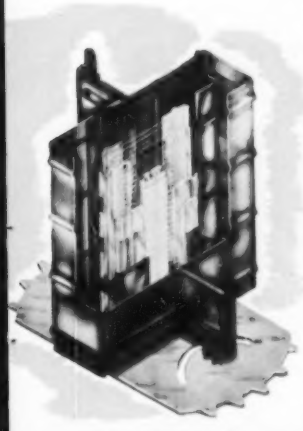


Double triode, type 7244, and single triode, type 7245

Stacked mount in glass bulb offers practical answers to industry's current needs

Sylvania's stacked mount structure is now available to design engineers because of a new glass envelope design that facilitates mass production of the tubes. Complete electrical, mechanical and environmental tests show that the new tube is capable of meeting the highest requirements of today's operational equipment. Its unique stacked construction offers an inherent ruggedness and reliability for superior vacuum tube performance. Actual test data comparing the stacked structure with conventional structures indicates as much as a 2 to 1 improvement in vibrational output at 6 times the G level.

The new stacked tube has already excited tremendous military interest. Eventually an entire line will be available for military and industrial applications.



▲ Cutaway view of the Framelok design

Widespread interest in Sylvania's exclusive Framelok design fosters new type development

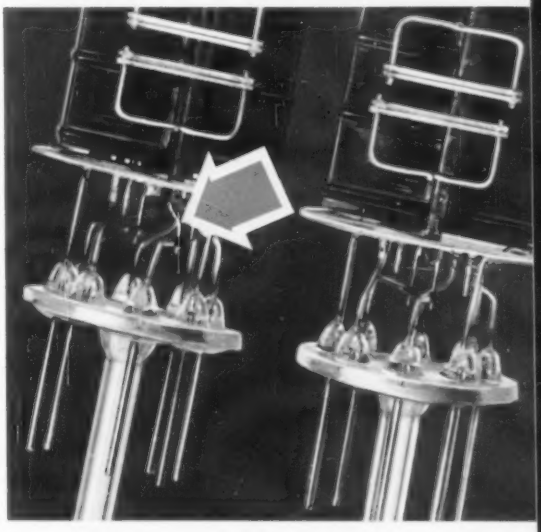
Accelerated development of new Framelok tube types is underway at Sylvania as a result of fast-growing acceptance of the revolutionary design shown for the first time at the 1958 IRE Convention.

Design engineers are already analyzing new circuit requirements in terms of the Framelok design. New application possibilities ranging from television to audio are developing rapidly.

Behind this widespread acceptance are these basic reasons why designers prefer the Framelok design over conventional types:

• Greater uniformity of electrical characteristics in tube after tube • Greater stability of electrical characteristics during tube life • Less change in electrical characteristics due to element temperatures at high dissipation levels • Better control of cutoff • Lower knee voltage—more uniform control of knee • Less chance for shorts, microphonism and noise • Better plate-to-screen current ratio • Higher screen grid dissipation • Less arcing.

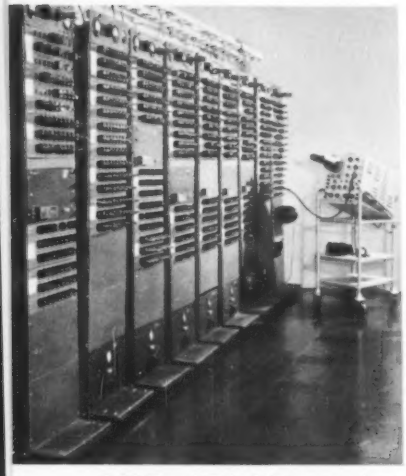
Send for your free copy of Sylvania's new Framelok Grid Booklet, including a grid sample, for full information on the electrical and mechanical characteristics of the Framelok design



Entertainment receiving tubes are subjected to military-type inspection procedures

These two mounts may look alike to the untrained eye . . . but trained inspection personnel can spot defects in one (left) that could cause future trouble. All Sylvania entertainment tube types must pass this visual mount inspection procedure based on that used for military types. As a result equipment manufacturers enjoy fewer line rejects, lower manufacturing costs.

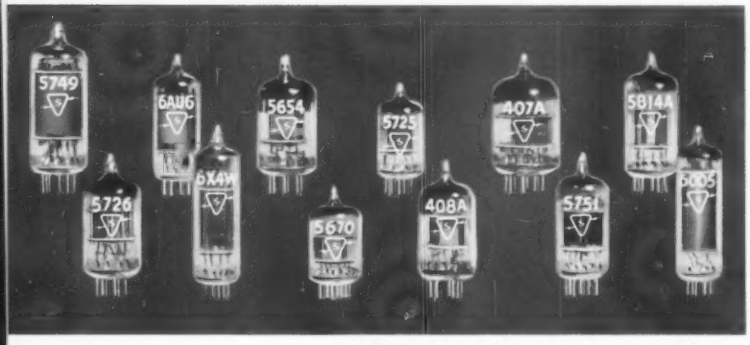
SYLVANIA SETS THE Gold Brand Standard



Gold Brand Subminiatures undergo 1,000-hour life tests

Life tests on subminiatures are increased to insure maximum reliability

Sylvania increases the life assurance on its premium subminiature tube line by increasing its life test program from 500 to 1,000 hours. The increase establishes additional positive proof of the high reliability and excellent performance of the subminiature tube line.



Gold Brand types meet rigid new specifications

Sylvania writes new Gold Brand Specs for commercial and industrial applications

To meet your needs for reliable tubes in commercial and industrial equipment, Sylvania has written new specifications which tailor military standards to commercial, and industrial requirements. Some of the typical controls specified for Gold Brand tubes include Multiple Life Tests ranging from 500 to 1,000 hours, Impact Shock Tests of up to 500 G, Fatigue Tests, Vibration Tests, Glass Strain Tests and Variable Control Tests.

The following are the 12 Gold Brand types on which full specifications are available:

Type	Description
407A	Medium-mu double triode (9-pin miniature)
408A	Sharp-cutoff pentode (7-pin miniature)
6AU6WA	Sharp-cutoff pentode (7-pin miniature)
6X4WA	Double diode (7-pin miniature)
5654	Sharp-cutoff pentode (7-pin miniature)
5670	Medium-mu double triode (9-pin miniature)

Type	Description
5725	Dual-control pentode (7-pin miniature)
5726	Double diode (7-pin miniature)
5749	Semi-remote cutoff pentode (7-pin miniature)
5751	High-mu double triode (9-pin miniature)
5814A	Medium-mu double triode (9-pin miniature)
6005	Beam Pentode (7-pin miniature)

Gold Brand types meet missile requirements

Gold Brand Premium Guided Missile types withstand severe durability tests

Every tube type in Sylvania's Gold Brand Guided Missile line meets environmental testing more severe than that required in many advanced military specs. Each type is subjected to severe vibrational fatigue tests at sweep frequencies from 30 cps to 3000 cps at 10 G's for 6 hours in several standard positions.

All Gold Brand Sylvania subminiature tubes undergo the White Noise Test. The tubes are subjected to a white noise vibrational spectrum covering the frequency band of 100 to 5000 cps., the rms G-level is 2-3 G's per octave with peak G-level of 15 G's. The tubes are tested for both rms and peak vibrational output and limits are established on each.

Type	Description
6946	Medium-Mu Triode
6947	Medium-Mu Double Triode
6948	High-Mu Double Triode
6788	Sharp cutoff audio-frequency pentode
6943	Sharp cutoff RF Pentode
6944	Semi-Remote cutoff RF Pentode
6945	Audio-Frequency Beam Pentode

Gold Brand subminiature Type 6814 meets rugged requirements of airborne computers

Type 6814 for missile computers

Prime example of a Gold Brand subminiature ideally suited for airborne computer use is type 6814. Fully proven in current operational equipments the tube features controlled sharp cutoff and zero bias plate current for good switching action. It exhibits exceptional freedom from development of cathode interface throughout life.

The 100% Production DC shorts test as well as a standard AC shorts test on type 6814 minimizes the possibility of flicker shorts—assuring greater reliability in this tube's many applications, particularly in switching and triggering circuits. In addition, it withstands a minimum 1000-hour life test.

You can get the complete engineering story on Sylvania's Gold Brand Lines in the new 33-page Gold Brand booklet.

IN NEW TUBE TYPES . . .

Five new types are added to the receiving tube line

Type 12DV8—Designed for 12-volt auto radios, this 9-pin miniature double-diode, space charge grid tetrode can be used as a combined detector, AVC rectifier and transistor driver. The tetrode section has the advantage of low R_p for better transistor matching.

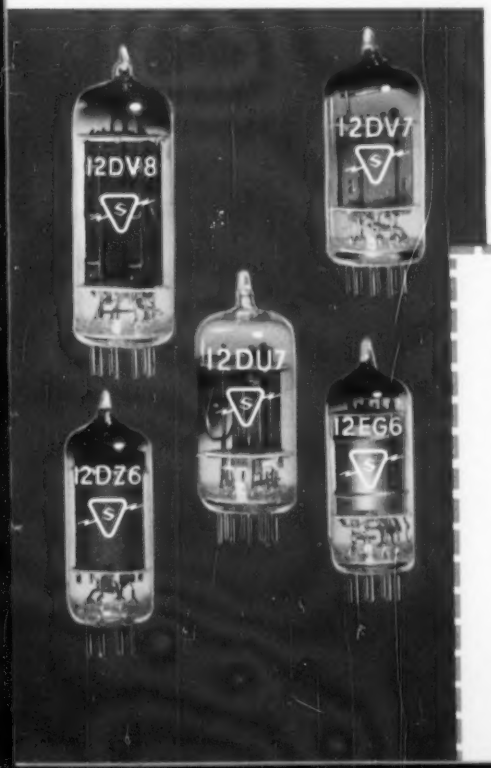
Type 12EG6—This tube is designed primarily for use in 12-volt auto radios as an RF amplifier. It is a 7-pin miniature dual control Heptode with a unipotential cathode. AVC voltage can be applied to two control grids reducing back biasing of the AVC line with large RF signals.

Type 12DZ6—This miniature pentode has a remote cutoff to give a Gm of 50 umhos at a bias of 10 to 12 volts for improved AGC characteristics in hybrid radio receivers. The plate resistance of 15,000 ohms, coupled with a Gm of 3600 umhos, insures high performance in weak signal areas.

Type 12DU7—This 9-pin miniature double diode-tetrode can be used as a transistor driver in addition to functioning as a detector and AVC rectifier in hybrid auto receivers. In this multipurpose, low-cost tube, power output distortion is controlled to a maximum of 5%.

Type 12DV7—A double diode-triode for use in 12-volt hybrid auto radios. With a 12-volt plate supply the triode features a plate current of 750 ua, a mu of 15 and a Gm of 1000 umhos. The diodes feature a separate cathode connection for maximum flexibility in detector and AVC circuits.

New receiving tube types



New five-inch experimental evaporated phosphor CRT

IN NEW TRANSPARENT PHOSPHOR TUBES . . .

Experimental five-inch evaporated phosphor CRTs offered for applications research and development

Steady progress is being made in the development of evaporated (transparent) phosphor cathode-ray tubes at Sylvania. Now 5-inch and other small tubes are being produced and are available for experimental purposes.

High industry interest in evaporated (transparent) phosphor tubes is centered around the major benefits the tubes offer over conventional CRT s. Among the more important characteristics are:

- **Higher resolution**—Transparent screens are capable of higher resolution than conventional settled screens because the phosphor crystals are smaller by many orders of magnitude. Video displays with sharper definition are possible.
- **Improved contrast** in high ambient light conditions—Transparent phosphors permit outside light to pass through the "screen" cutting reflection to a minimum. This characteristic is highly important where scopes must operate in high ambient light.
- **Minimum Screen Noise**—Because evaporated phosphor crystals are much smaller than those in conventional coatings, screen noise, the interplay of light reflections on the crystal faces, is reduced. The result is sharpest possible definition.
- **More Uniform Light Output**—The phosphor coating on evaporated screen CRT s is some 10 times as thin as standard coatings. This smooth screen coating contributes to far greater uniformity in light output.
- **Less Screen Burn**—Transparent phosphor tubes offer better resistance to screen burning because the crystals are closer to the glass faceplate. This allows better heat dissipation and cooler operation.

Since all of these advantages are not available in a single evaporated phosphor tube design, it is necessary to specify which characteristics are most important for the intended application. Send full information on your particular application when you request experimental samples. Write to Sylvania direct or call your Sylvania representative.

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Buffalo 9, N.Y.

In Industrial Television . . .

Special CRT is specifically designed for industrial TV monitor use

Now, higher fidelity in industrial television is possible with new cathode-ray tube, type 8FP4. It gives added definition and resolution to industrial television performance.

Type 8FP4 is an 8" rectangular all-glass, magnetic focusing tube with an ion trap and 90° magnetic deflection.

New test picture tube speeds receiver production line testing

A new 8" 110° test picture tube, type 8YP4, is specifically designed for television receiver and picture tube testing. Its small size, light weight and convenient shape make it the ideal production line test tube.

The 8YP4 is equipped with a conventional base and a convenient adaptor for conversion to a rigid pin base. It has built-in automatic electrostatic self-focusing making external focus connections or adjustments unnecessary. It employs a 6.3 volt, 600 ma heater that will also operate in 450 ma series heater strings.

New ITV monitor

In Industrial and Military C-R Tubes

New CRT type 5ADP2

New high-precision scope tubes, types 5ADP, 5ABP, and 5AQP, were developed for photography, radar and specialized uses

Sylvania again expands its line of special-purpose industrial and military cathode-ray tubes with a series of high-precision types designed for specialized uses. These tubes incorporate a high-precision electron gun made to ultra-fine tolerances. Sharp clean scope presentations result for high-precision photography.

The new tubes, types 5ADP, 5ABP, and 5AQP, are available in screen phosphors ranging from P1 to P11.

In Television Picture Tubes . . .

Sylvania combines the advantages of 110° deflection and 450 ma heater in three new picture tubes

Type 24AQP4 with 450 ma heater

Sylvania, trend setter in electron-tube design, has developed new 110° picture tubes incorporating the 450 ma 6.3 volt heater. The new tubes, types 17CTP4, 21DHP4 and 24AQP4, combine the space savings of 110° tubes with the power and cost advantages of 450 ma heaters. The low power heater not only reduces heat with total set power savings of approximately 18 watts but permits use of a lower wattage, less expensive series resistor. The end result is a line of picture tubes that meet the needs of new portable and console TV receiver designs.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
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In Canada: Sylvania Electric (Canada) Ltd.
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ENGINEERING DATA SHEETS

Receiving Tubes
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- ☐ 7245
- ☐ 12DV8
- ▶ ☐ 12EG6
- ▶ ☐ 12DZ6
- ☐ 12DU7
- ☐ 12DV7

Cathode-Ray Tubes
- ☐ 5ABP
- ☐ 5AQP
- ☐ 5ADP
- ☐ 8FP4
- ☐ 8YP4
- ☐ 17CTP4
- ☐ 21DHP4
- ☐ 24AQP4

- ☐ Sylvania Framelok Grid Booklet
- ☐ Sylvania Gold Brand Booklet
- ☐ Additional explanation, and application requirement form for Sylvania transparent phosphor CRT s

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Use this handy business reply card to request additional information on these important new Sylvania developments

Modernize Now for Growth and Profits

A Special Report from McGraw-Hill to America's Business Executives

THE EDITORS of all McGraw-Hill publications are now devoting their full energies to documenting what needs to be done *now* to assure success in the 1960s for:

1. Individual companies in the key areas of business and industry these publications serve
2. The business community as a whole
3. The nation—in its fateful economic competition with the Soviet Union. The U. S. State Department has characterized this economic challenge as "the most dangerous of all" confronting us.

These editorial features will concentrate on what can be done *now* by modernization and improvement of plant and equipment to raise productivity and insure profitable growth ahead. They will appear early this fall in our 34 business and technical magazines, to assist industry in planning for the future.

We believe this special editorial undertaking by all of our publications, working as a team, will prove another landmark in our continuing efforts to speed America on the road to full economic recovery and sustained economic growth.

Donald C. McGraw

PRESIDENT

and the U. S. is her best customer.

New stereophonic records and a studio for stereophonic tape recording will be shown.

There will be 160 exhibitors in all, of which 36 are radio and tv setmakers. More of the following will be in evidence this year: portable and transportable tv receivers; tv sets equipped to receive vhf/f-m sound broadcasting; receivers using transistors and printed circuits. Some emphasis will be given to export models.

Manufacturers of tubes, components, test and measuring gear are exhibiting, and the Royal Navy, Royal Air Force and the General Post Office will show some of their applications of electronics.

Wescon Offers Timely Panels

LOS ANGELES—Wescon wants to learn your viewpoint next week. With increased emphasis on panel discussions, greater audience participation is solicited in technical sessions at the Ambassador Hotel here. The convention starts Tuesday, ends Friday.

Invited panelists for reliability sessions include civilian experts on Thor and Atlas, and a military representative from ARDC. Office of Assistant Secretary of Defense is furnishing the moderator and discussion will center around contract implications of reliability requirements for military electronics.

Panelists will point out why reliability must encompass far more than just manufacturing phase. They'll discuss significance of recently rewritten military specs, and the type of system companies need to cope with new requirements.

Cosponsored by IRE medical electronics, and telemetering and remote control professional groups, another panel will explore measurement problems created by man's impending conquest of space.

To date, the medical profession and allied biophysical and physiological scientists have solved most of their own measurement problems. Now, they'll have to rely largely on telemetering equipment and personnel. Existing gear is not adequate for all jobs, and panelists hope that a delineation of problems will result in development of necessary equipments and techniques.

Radio to Run Traffic in N. Y.

Traffic control authorities in New York recently announced a plan which may mean expenditures as high as $200,000 a year solely for radio equipment to control traffic signal lights. The plan calls for an installation program that will continue indefinitely until all major thoroughfares in greater New York are provided with radio control equipment.

First phase expenditure of $190,000 is now before the city board of estimate for approval. Sum would be used for regulating a six-mile portion of a major roadway in the Queens County section of the city. Completion of the installation is expected by next summer.

Here's how the system will work: A transmitter will be constructed in each of the five boroughs. The stations will initiate signals governing operation of the traffic lights in accordance with 18 "programs" prepared to cover a variety of traffic situations. These will be derived from prepared punch cards and broadcast in the 952 to 960-mc band.

Each traffic light in the system will contain a receiver which will respond to signals intended for it. New York's director of intersection control told Electronics this will probably be done by a three-pulse system. The first two pulses will govern geographic location by street and intersection. The third pulse will cause the light to display the required signal.

Economies possible with the radio control system make traffic experts feel there's hope of approval for expenditures. Present networks to control traffic lights, which average about 10 to the mile, cost New York about $50,000 a mile. Radio system costs about $15,000 a mile.

MEETINGS AHEAD

Aug. 19-22: Western Electronic Show and Convention, WESCON, IRE, WCEMA, Pan Pacific Auditorium, Ambassador Hotel, L. A.

Aug. 19-22: Pacific General Meeting, AIEE, Senator Hotel, Sacramento, Calif.

Aug. 26-Sept. 6: British National Radio Show, Radio Industry Council, Earls Court, London.

Sept. 9-11: Applied Meterorology Engineering, Second National Conf., Univ. of Mich., Ann Arbor.

Sept. 10-12: Tube Techniques, Fourth National Conf., Advisory Group on Electron Tubes, OSD, Western Union Auditorium, N. Y. C.

Sept. 12-13: Communications Conf., IRE, Sheraton Montrose Hotel, Cedar Rapids, Iowa.

Sept. 15-19: Thirteenth Annual Instrument-Auditorium Conf. and Exhibit, ISA, Philadelphia Convention Hall, Pa.

Sept. 18-19: National Assoc. of Broadcasters, Fall Conf., Buena Vista Hotel, Biloxi, Miss.

Sept. 22-24: National Symposium on Telemetering, Americana Hotel, Miami Beach, and Patrick Air Force Base (Sept. 25).

Sept. 24-25: Industrial Electronics, Seventh Annual Conf., IRE, AIEE, Rackham Memorial, Detroit, Mich.

Sept. 29-Oct. 3: Audio Engineering Society, 10th Annual Conv., Hotel New Yorker, N. Y. C.

Oct. 1-2: Radio-Interference Reduction, U. S. Army Signal Research & Devel. Labs., IRE, Armour Research Foundation, Chicago, Ill.

Oct. 6-8: Symposium on Extended Range and Space Communications, IRE and George Washington Univ., Lisner Auditorium, Wash, D. C.

Oct. 8-10: IRE Canadian Convention and Exposition, Electronics and Nucleonics, Exhibition Park, Toronto, Canada.

Oct. 13-15: National Electronics Conf., 14th Annual, Hotel Sherman, Chicago.

Oct. 20-21: Aero Communications Symposium, Fourth National, PGCS, Hotel Utica, Utica, New York.

Oct. 20-21: USA National Committee, URSI Fall Meeting, Penn State Univ., University Park, Pa.

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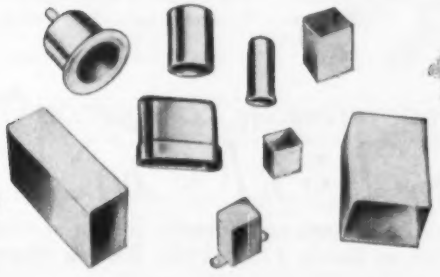
1 COMPLETE SERVICE ON MU METAL FABRICATION

HUDSON is now able to supply MU Metal closures in all standard sizes and shapes. Stock supply assures prompt delivery. Consult HUDSON on all your electrical alloy requirements.



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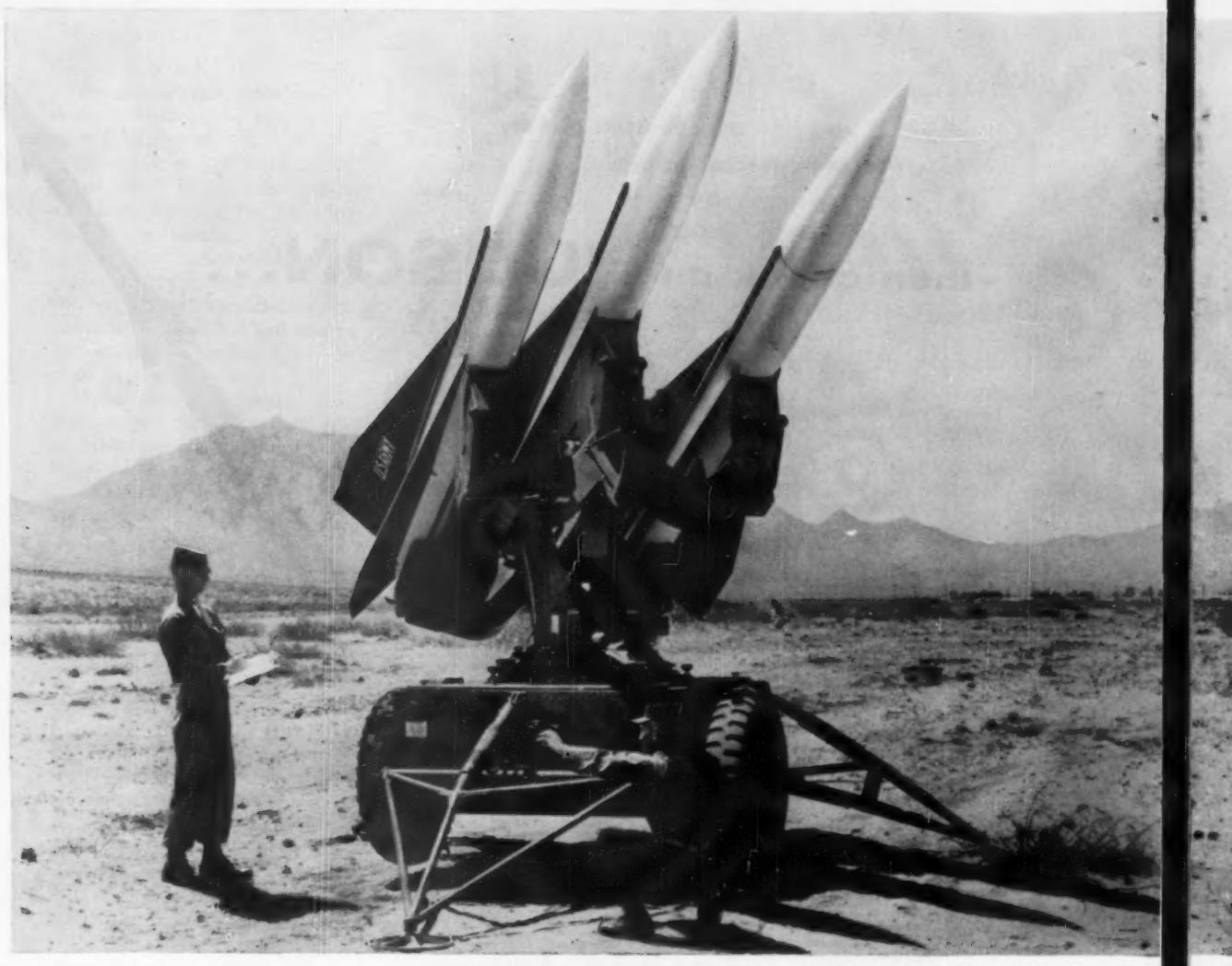

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Ten families of Cambion quality components — guaranteed unconditionally in any quantity

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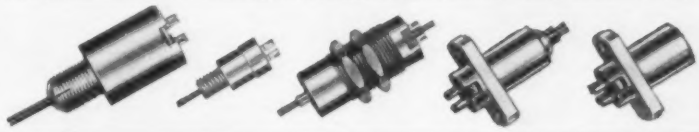

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Miniaturized Variable Ceramic Capacitors that outperform much bigger capacitors. (*Extreme right*): Stand-Off Capacitors with ceramic dielectric. Rugged R-F by-pass capacitors for high quality equipment. Shock-, vibration-, humidity-resistant.

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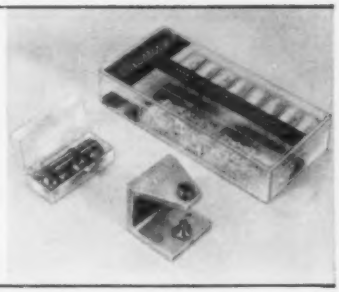
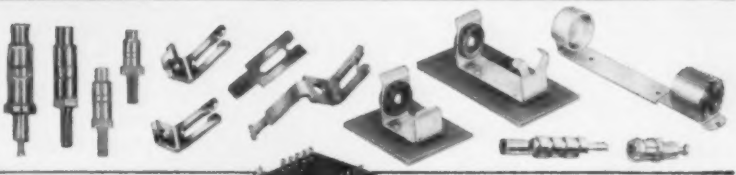
CAMBION QUALITY KITS

Design your electronic equipment around standard components, using four convenient CAMBION kits: Coil Form Kit, Coil Kit, Choke Kit, Solder Terminal Kit (illustrated).



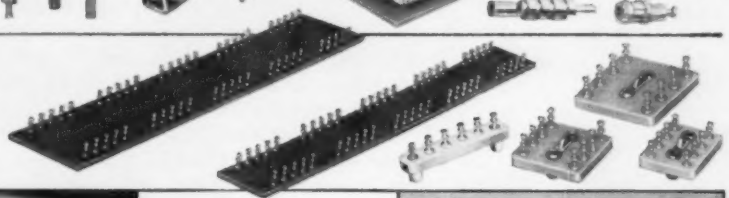
CAMBION QUALITY DIODE CLIPS

Seven different types, including rivet and spring-loaded units primarily for holding fragile pigtail leads from .005" to .085" in diameter. Also, one-, three-, and five-cell battery clips and miniature plugs and jacks.



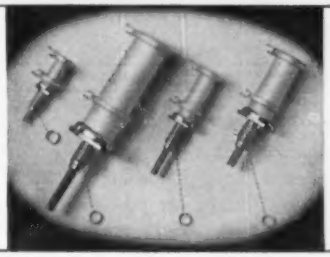
CAMBION QUALITY TERMINAL BOARDS

Custom-made, standard all-sets, standard ceramics. Variety of materials available — paper, cloth, nylon, glass laminates — phenolic, melamine, epoxy, silicone resins. Moisture- and fungus-proofed.



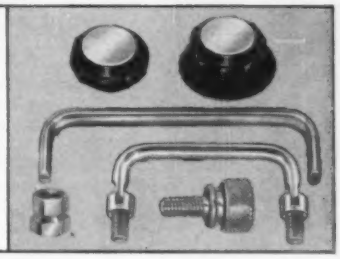
CAMBION QUALITY PERMA-TORQ® COIL FORMS

Constant-tensioning devices for tuning cores of standard CAMBION ceramic coil forms. Keeps coils tuned as set despite shock, vibration.



CAMBION QUALITY KNOBS AND PANEL HARDWARE

Selected materials, carefully processed and finished. Metal parts polished before plating. Hard-wearing surfaces, lasting lusters.



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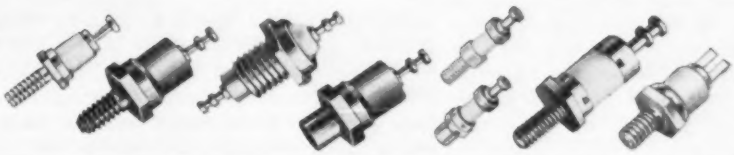
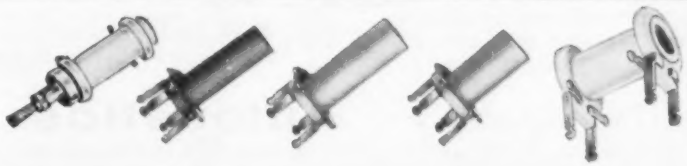
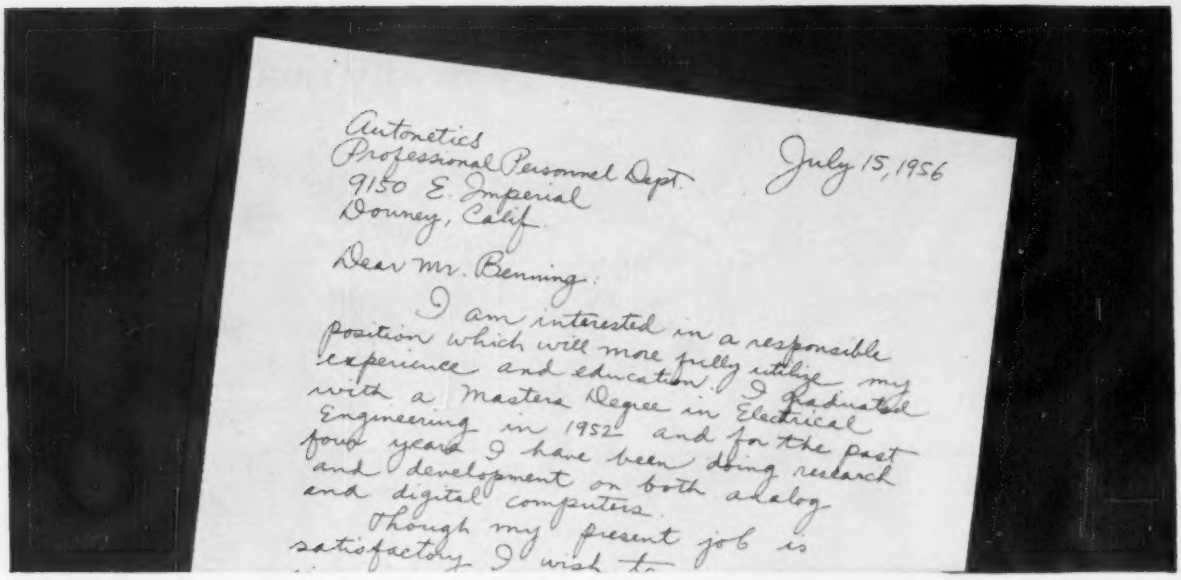
Wide variety of stand-off and feed-through models in Teflon and ceramic. Extremely resistant to shock, vibration, moisture and temperature. Solder terminals hold even after prolonged soldering operations.



CAMBION QUALITY PRINTED CIRCUIT COIL FORMS

Phenolic and ceramic types. Can be soldered after mounting. Available as forms alone or wound as specified. Two- to six-terminal models.

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I am interested in a responsible position which will more fully utilize my experience and education. I graduated with a Masters Degree in Electrical Engineering in 1952 and for the past four years I have been doing research and development on both analog and digital computers.
Though my present job is satisfactory I wish to

This letter moved an engineer ahead 5 years

Two years ago a man took 10 minutes to write this letter. Today he enjoys the responsibility and professional standing in the Autonetics Division of North American that might have taken 5 years to achieve elsewhere.

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HELIAX is normally supplied as an assembly, complete with end fittings factory attached, reducing installation labor and improving quality.

Complete uniformity throughout its entire length gives HELIAX *superior* electrical characteristics.

HELIAX is always less difficult, less costly to install, *easier to handle*.

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Read directly

1μμa

and

1μv

with 10 times previous accuracy!

Drift less than ± 2 μv; noise less than 0.2 μv!

New -*hp*- 425A Microvolt-Ammeter

now makes these difficult measurements quickly and easily!

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Minute dc potentials, difference voltages, nulls

Resistances from milliohms to 10 megmegohms*

Use with Esterline-Angus, other recorders

PHYSICS, CHEMISTRY

Grid, photomultiplier currents

Ionization levels in vacuum

Thermocouple potentials

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MEDICINE, BIOLOGY

Voltages in living cells

Nerve voltages

Voltages in plants, seeds

*with external dc source.

hp is announcing more than 30

The all-new -*hp*- 425A Microvolt-Ammeter will provide engineers, physicists, chemists and physiological scientists with one compact, direct-reading instrument measuring minute voltages and currents with speed, simplicity and 10 times the sensitivity of the complex equipment arrays previously required.

Very careful engineering, including heavy filtering against ac signals and substitution of a unique photoelectric chopper for the conventional mechanical vibrator, has resulted in performance heretofore unobtainable. The long-term drift of the 425A is less than 2μv and internal noise is less than 0.2 μv.

Conservative electrically, Model 425A includes every conceivable assurance of safety, accuracy and dependability. For example, momentary overloads of 1,000 volts cause no damage; and the new pickup probe is specially designed to minimize thermocouple and triboelectric effects. The meter provides constant polarity indication.

The new -*hp*- 425A also may be used to measure a wide range of resistances. Milliohms may be measured by using a battery and series resistor as a constant current source. Higher resistances may be measured with higher voltages; a 100 volt supply allows the 425A to measure accurately up to 10 megmegohms.

Call your -*hp*- representative now for demonstration on your bench; or, write for details.

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FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

SPECIFICATIONS

MICROVOLT-AMMETER

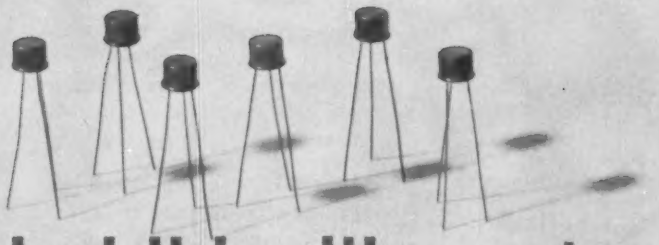
Voltage Range:	Positive and negative voltages from 10 μv full scale to 1 v full scale in an eleven step, 1, 3, 10 sequence.
Current Range:	Positive and negative currents from 10 $\mu\mu$a full scale to 3 ma full scale in an eighteen step, 1-3-10 sequence.
Input Impedance:	Voltage Ranges: 1 megohm $\pm$5%. Current Ranges: Depends on range, 1 megohm to 0.33 ohm.
Accuracy:	Within $\pm$3% of full scale.

AMPLIFIER

Frequency Range:	dc to 0.2 cps.
Gain:	100,000 maximum.
Output:	0 to 1 v for full scale reading, adjustable.
Output Impedance:	10 ohms, shunted by 1000 ohm potentiometer.
Noise:	Less than 0.2 μv rms referred to input.
Drift:	After 15 minute warm-up, less than $\pm$2 μv per hour referred to the input.
Power:	115 v $\pm$10 v, 230 $\pm$20 v, 60 cps, 40 watts.
Dimensions:	Cabinet Mount: 7½" wide, 11¼" high, 14" deep.
Weight:	Net 20 lbs.
Price:	$500.00. -*hp*- 425AR (rack mount) $505.00. -*hp*- 425A (cabinet) $500.00.

Data subject to change without notice. Prices f.o.b. factory.

basic new instruments in 1958



Fairchild silicon transistors

Milli-micro-second switching speeds and high current too

Where applications require transistor performance beyond previously accepted high limits, Fairchild Silicon Transistors offer an exceptional three-way combination:

1) 50 milli-micro-second typical rise time — permits faster switching rates in computing devices. Total switching time is typically 0.2 microseconds.

2) 1 watt dissipation at 100° C. — Saturation resistance is 10 ohms maximum. Resulting high-current capability provides opportunities to increase equipment performance while reducing circuit complexity.

3) Silicon temperature performance — Maximum junction temperature of 175° C. gives low leakage and more safety factor at any lower temperature.

These characteristics are the outcome of the solid-state diffusion technique used at Fairchild. Other important accomplishments of this process are excellent reliability and a high order of electrical uniformity throughout large production runs.

The accomplishment of a research-production team
Singleness of purpose did it. Fairchild assembled a uniquely experienced team of research scientists and production engineers whose objective was to bring the advanced solid-state diffusion process under close control. They succeeded in putting laboratory-quality silicon transistors into quantity manufacture with firm product specifications exceeding anything previously offered.

2N696 and 2N697 SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	40v		
P_C	Total dissipation Case temp. 25° C. Case temp. 100° C.	2 watts 1 watt		
h_{FE}	D.C. current gain		2N696 — 15 to 30 2N697 — 30 min.	I_C = 150ma V_C = 10v
R_{CS}	Collector saturation resistance		6Ω typical, 10Ω max.	I_C = 150ma I_B = 15ma

For full information and specifications, write Dept. A-8

FAIRCHILD
SEMICONDUCTOR CORPORATION

844 CHARLESTON ROAD • PALO ALTO, CALIFORNIA
VISIT US AT BOOTH 1632 AT THE WESCON SHOW

The unretouched scope face below shows the time comparison of input (positive) and output (negative) pulses in a non-saturating mode. Time base is 20mμsec. per large division on the scope face. Maximum collector current is 50 ma.

NEW HERMETICALLY SEALED HIPERMAG CORE

PERMITS ENCAPSULATING, IMPREGNATING, OTHER PROCESSING . . . WITH NO CHANGE IN MAGNETIC VALUES

Newest development in cores for magnetic amplifier applications is the Westinghouse Polyclad hermetically sealed Hipermag core.* Polyclad insulation is applied over a new specially designed aluminum box housing the core. This hermetically seals the core and allows encapsulating, casting or impregnating—without altering magnetic properties . . . Eliminates magnetic amplifier rejects caused by changed magnetic values.

Tested for all environmental conditions, Polyclad insulation is suitable for high temperatures, protects against humidity and high-voltage stress, provides high insulation strength, with breakdown values up to 3000 volts.

Polyclad coating eliminates the need for core taping; makes possible reduced insulation cost. Rounded corners prevent shorting wire to core, allow winding directly on the core.

These cores are supplied in special sizes or in standard AIEE sizes, in one-, two-, or four-mil oriented nickel-iron alloy Hipernik® V and in one- or two-mil 4-79 Permalloy. Complete listing in Westinghouse publication 44-720.

Hermetically sealed Hipermag cores are available in production lots with normal delivery. All Hipermag cores are tested — by Roberts constant-current, flux reset technique, or to your specifications.

For more information about Polyclad hermetically sealed Hipermag cores and other Hipersil® or Hipermag cores, call your Westinghouse representative . . . or write Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania.

*Patent applied for

J-70892

YOU CAN BE SURE...IF IT'S Westinghouse

NEW DAYLIGHT PORTABLE OSCILLOSCOPE

Bright Trace

High Performance

Courtesy Commander 337th Fighter Group, U. S. A. F.

TYPE 317

It's excellent for the daylight conditions often encountered in the field and at production test stations. The brilliant trace, provided by 10-KV accelerating potential on a new Tektronix 3-inch cathode-ray tube, is easily readable in bright areas, even at low sweep-repetition rates. And its DC-to-10 MC vertical response easily takes care of most of today's complex field applications.

The Type 317 is an excellent laboratory oscilloscope, too. Ask your Tektronix Field Engineer or Representative to arrange a demonstration in your most demanding applications.

TYPE 317 CHARACTERISTICS

VERTICAL RESPONSE

Passband—dc to 10 mc.
Risetime—0.035 μsec.
Sensitivity—0.1 v/div to 125 v/div, dc-coupled and ac-coupled—0.01 v/div to 0.1 v/div, ac-coupled only. Twelve calibrated sensitivity steps.

SWEEP RANGE

0.2 μsec/div to 6 sec/div. 22 calibrated steps from 0.2 μsec/div to 2 sec/div.
5-x magnifier increases calibrated sweep rate to 0.04 μsec/div.

TRIGGERING

Preset or manual stability control with amplitude-level selection, and fully-automatic triggering.

ACCELERATING POTENTIAL

10-KV on new Tektronix high-voltage 3-inch cathode-ray tube.

CALIBRATOR

Amplitude calibrator, 0.05 to 100 v in 11 steps, square-wave frequency about 1 kc.

OTHER FEATURES

Electronic power-supply regulation.
External input to horizontal amplifier.
Warning lights for uncalibrated sweep-rate and sensitivity settings.
Magnifier indicator light.
Size—8½" wide, 12" high, 19½" deep.
Weight—35 lbs.

Type 317 . . . **$800** (50 to 60 cycle supply).
Type 317 MOD101 . . . **$835** (50 to 800 cycle supply).
f.o.b. factory

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albertson, L. I., N. Y. • Albuquerque • Bronxville, N. Y. • Buffalo • Cleveland • Dallas • Dayton • Elmwood Park, Ill. • Endwell, N. Y. • Houston • Lathrup Village, Mich. • East Los Angeles • West Los Angeles • Minneapolis • Mission, Kansas • Newtonville, Mass. • Palo Alto, Calif. • Philadelphia • Phoenix • San Diego • Syracuse • Towson, Md. • Union, N. J. • Willowdale, Ont.

TEKTRONIX ENGINEERING REPRESENTATIVES: Arthur Lynch & Assoc., Ft. Myers, Fla., Gainesville, Fla., Bivins & Caldwell, Atlanta, Ga., High Point, N. C., Hawthorne Electronics, Portland, Ore., Seattle, Wash., Hytronic Measurements, Denver, Colo.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

THE NEW LIGHTWEIGHT A-MP "240" PATCHCORD PROGRAMMING SYSTEM

. . . means lightning fast in-flight reprogramming of airborne electrical/electronic circuitry . . . obsoletes fixed circuit connectors and other systems requiring hours or days to rewire . . . and offers these unusual features:

- removable patchboards to permit complete reprogramming in seconds
- 3¼ pounds to minimize weight . . . miniaturized to conserve space
- rugged shock and vibration-resistant construction with high strength aluminum alloy
- shock-resistant seating of patchcord plugs in removable board
- AMP's patented wiping action that pre-cleans contacts for top electrical performance
- 240 contacts for greatest versatility in circuit combinations or program arrangements

For more information on this new airborne wiring technique, AMP's Patchcord System Catalog is available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

Unique combination of performance, size and price

OVER 1000 TIMES AS SENSITIVE as galvanometer recorders . . . and Varian's null-balance potentiometer needs no power from the source being measured. Rugged, stable mechanism allows ink or inkless recording — easy-to-read rectilinear chart — source impedances of up to 100,000 ohms.

LESS THAN HALF AS WIDE as a standard 19-inch rack. Two Varian G-11A's mount side by side on a rack panel 10⅜ inches high. Or as a portable, the G-11A is an easy-to-handle 15 pounds. The G-10 sits on less than one square foot; its horizontal chart is handy for jotting notes.

MORE VERSATILE AND ADAPTABLE than any similar recorder — adjustable zero, adjustable span (from 9 to 100 mv on the G-11A), multiple chart speeds (up to four on the G-11A), and plug-in input chassis for different recording requirements.

PRICES THAT BEGIN AT $340 for the G-10 and $450 or the G-11A. Because unneeded performance costs money, Varian has intentionally designed for 1% limit of error and 1-second balancing time. Thus, Varian provides needed ruggedness, dependability and operating features at moderate cost.

VARIAN STRIP CHART RECORDERS

Varian G-11A for panel, rack or portable use for laboratory or equipment builder.

Varian G-10 bench-top recorder for accessible, horizontal chart.

WRITE TODAY FOR COMPLETE SPECIFICATIONS AND STANDARD OPTIONS

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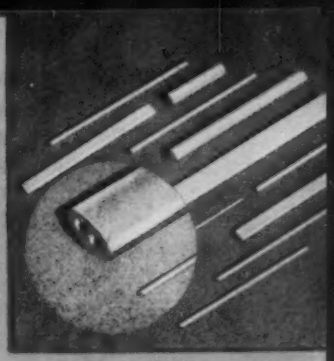
CIRCLE 25 READERS SERVICE CARD→

AlSiMag®

DATA FOR DESIGNERS

Abrasion Resistant

and Blast Nozzles. Spray Nozzles. erd, homogeneous, long-lived. Suited the most exacting uses.



Precision Tolerances

Minute, yet strong tubing of AlSiMag Alumina. Parts in inset magnified three times (smaller one .013" OD); others approximate actual size.

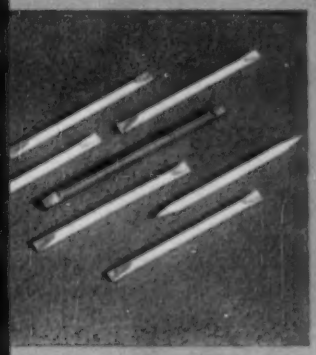
NEW!

AlSiMag Alumina Ceramics open new fields for designers . . . permit designing to higher temperatures, higher frequencies, greater strengths.

Designers are generally familiar with the plus values of AlSiMag technical ceramics for standard industry applications. However, recent developments—particularly in new, high-strength, high-temperature AlSiMag Aluminas—have greatly enlarged their range of usefulness.

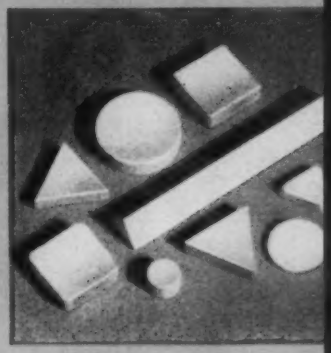
Do you need a material with such versatile characteristics as shown on this page? AlSimag technical ceramics have helped many designers solve problems . . . may help solve yours. Send blueprint with complete operating details for our recommendations.

Visit our Booths Nos. 606-607 at WESCON



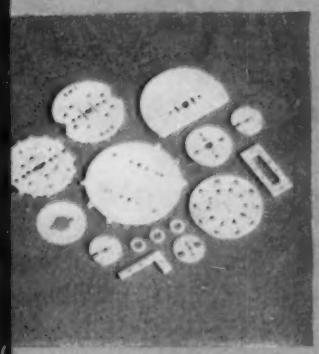
Non-Inductive

Alignment Tool Blades. Non-metallic, or sensitive machine and instrument ettings—other demanding applications.



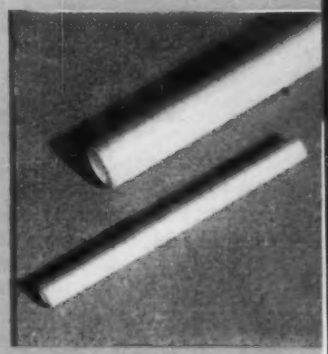
Hard

AlSiMag Tool Tips for cutting and machining strongest alloy steels.



Thin . . . Strong

Electron Tube Spacers as thin as .009" ave remarkable strength. Similar parts might solve other application problems where superior insulation is needed.



Durable

Rollers for flattening inductance wire—a new application for AlSiMag.

AMERICAN LAVA

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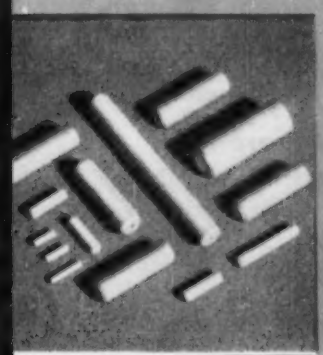
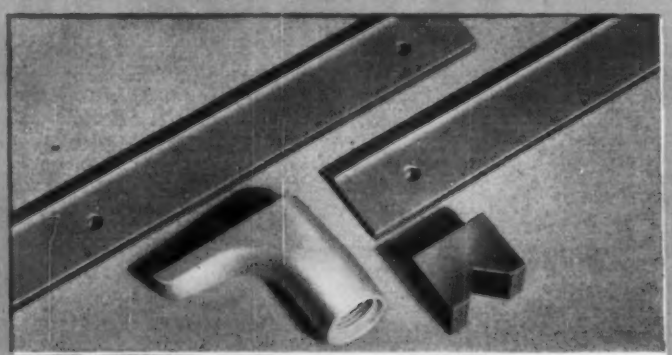


Precision Finishes

Smooth, easily coated AlSiMag Cores for Ink, Metal Film and Carbon Deposited Resistors.

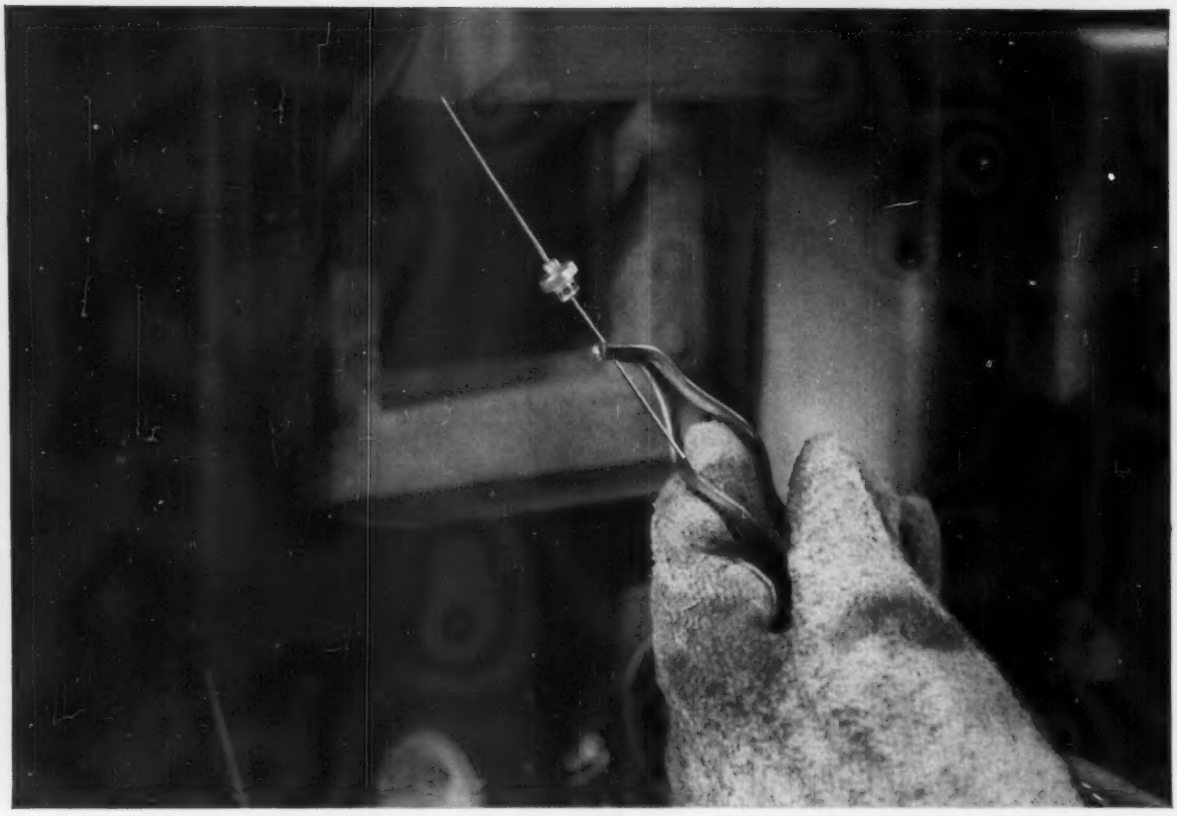


Heat Resistant

Support Rings for Heat Treating Fixtures. Welding Jigs. Hold-down Jigs for heat applications.

Acid Resistant

Rotary Seals and Plungers. Extraordinary wearing qualities. Surface finishes to meet exacting specifications.



another NEW Mallory Tantalum

150°C service . . . miniature size

From Mallory, another industry first . . . miniature high temperature tantalum capacitors capable of operation up to 150°C. Identified as the M2 line, these capacitors feature glass-to-metal hermetic seals, preventing any loss of electrolyte. They will withstand 2000-cycle vibration in accordance with MIL-C-3965B. The extremely rugged design, which enables their use under severe environmental conditions, and small size, only 0.5″ long x 0.287″ body diameter, 0.484″ flange diameter, make them particularly useful in missile and aircraft electronic systems.

The M2 series is the latest addition to Mallory's complete line of tantalum capacitors, which gives designers coverage in tantalum of capacities from .22 to 1300 mfd., voltages from 3 to 630, and temperatures from 85 to 200° C. The following ratings are available in the M2 line:

Type	Mfd.	Working Voltage—DC		
		85°C	125°C	150°C
M2-11	11	90	80	75
M2-15	15	75	67	62
M2-20	20	60	50	48
M2-25	25	50	42	40
M2-40	40	30	25	23
M2-70	70	15	13	12
M2-100	100	10	8	7
M2-140	140	6	5	4

Ask the man from Mallory for more data and application engineering assistance—or write, today.

Expect more...get more from

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MALLORY

P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

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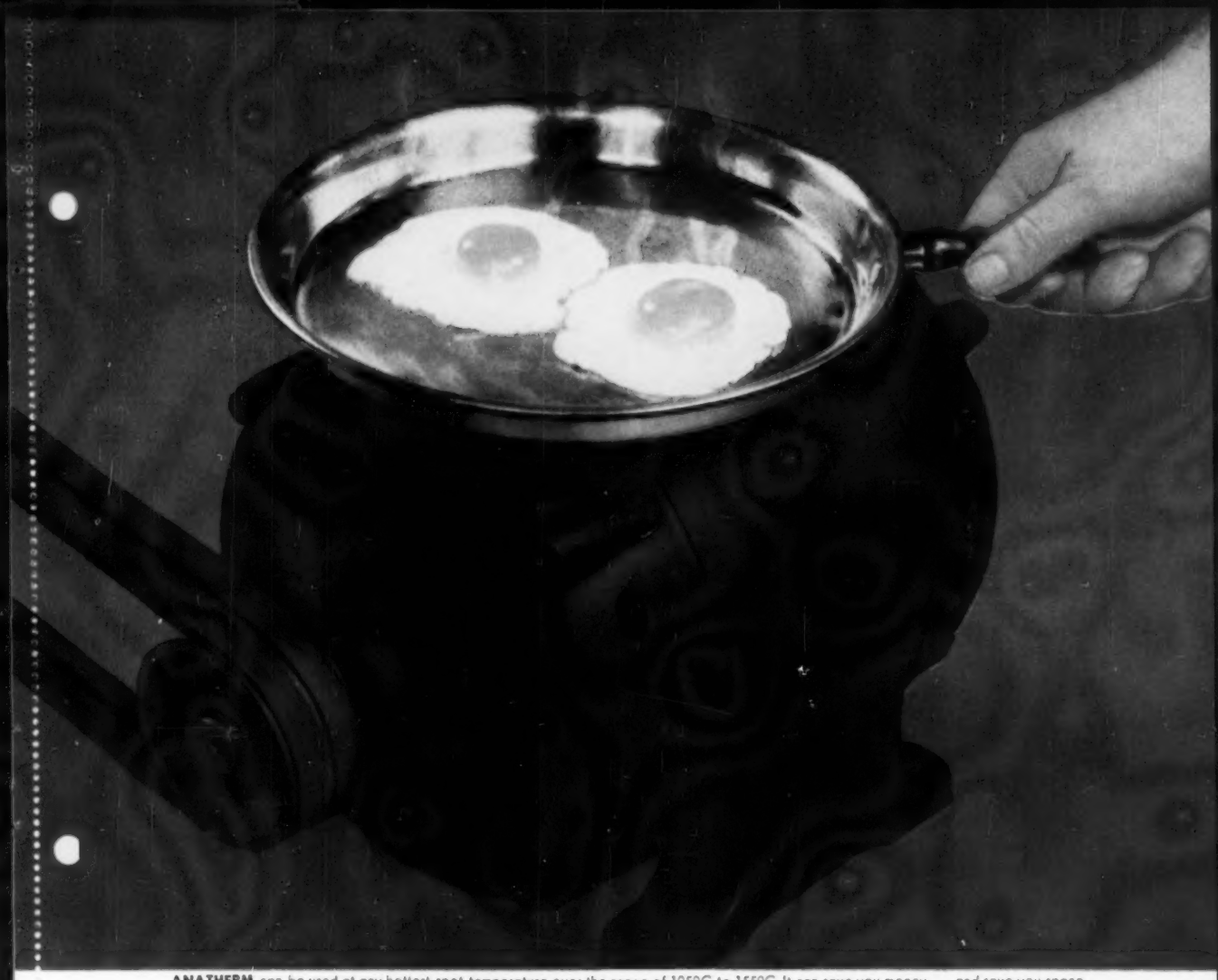
Parts distributors in all major cities stock Mallory standard components for your convenience.

CIRCLE 26 READERS SERVICE CARD

CIRCLE 27 READERS SERVICE CARD→



ANATHERM can be used at any hottest-spot temperature over the range of 105°C to 155°C. It can save you money . . . and save you space.

More horsepower per pound–it's yours with 155°C Anatherm

First polyester high temperature enamel magnet wire available in complete range of sizes—round, square, rectangular.

Of course you don't fry eggs on them, but motors are being run hotter today. These higher operating temperatures can put you on a *hot spot* with your customers—if motors fail.

Solution: Anaconda Anatherm Magnet Wire. Anatherm is a new polyester film-coated wire—fully tested for use at "hottest spot" temperatures up to 155°C. With this new higher level of thermal stability, Anaconda Anatherm is the first film-coated wire to meet the newly adopted 155°C (AIEE Class F) rating!

Greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength—make Anatherm ideally suited for a variety of applications. It's especially practical where maximum performance and reliability are required from smaller equipment operating at higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any hottest-spot temperature from 105°C to 155°C.

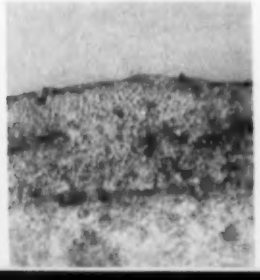
Available in standard film-thickness of round wires, sizes 8 to 46, inclusive, and in a full range of sizes of square and rectangular wires. For more information, see the Man from Anaconda. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Co., 25 Broadway, N. Y. 4, N. Y.

ASK THE MAN FROM ANACONDA® *ABOUT* **ANATHERM MAGNET WIRE**

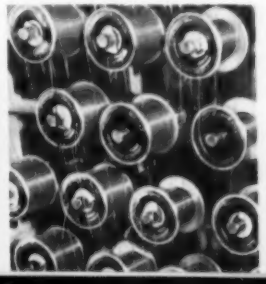
For you, Anatherm can mean smaller electrical equipment... higher operating temperatures. See details on reverse side—

ANALAC 105°C (AIEE Class A) solderable magnet wire

VITROTEX 130°C (AIEE Class B) glass-insulated, high heat resistance

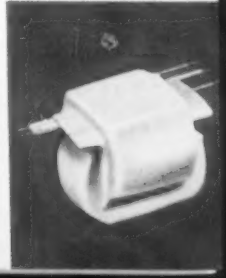


PLAIN ENAMEL 105°C (AIEE Class A) low-cost enameled magnet wire



NYFORM 105°C (AIEE Class A) superior windability

EPOXY 130°C (AIEE Class B) general compatibility



MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

IMPORTANT FACTS FOR YOUR WORK...

...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anaconda Anatherm's higher 155°C characteristics, electrical equipment can be improved in these ways:

RAISES LIMITING OPERATING TEMPERATURES. Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection . . . longer equipment life . . . wider range of applications.

REDUCES FRAME SIZE. Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

INCREASES HORSEPOWER RATINGS. Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

UPGRADING. Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

COMPATIBILITY. With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

ELECTRICAL PROPERTIES

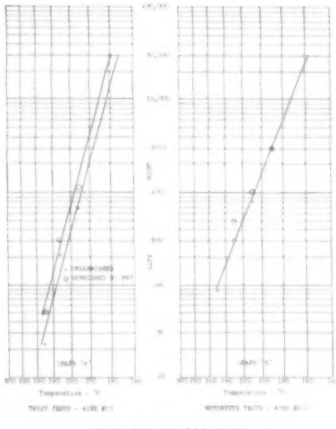
Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and/or enclosed systems are concerned. Similar precautions must be taken where chlorine-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalies.

THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anaconda engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.



Valuable Anatherm Magnet Wire Handbook—
yours for the asking!
Latest information . . . full technical data.

TEAR OUT FOR YOUR FILE

ANACONDA WIRE & CABLE COMPANY
25 BROADWAY, NEW YORK 4, NEW YORK

Please send me a copy of your Anatherm Magnet Wire Booklet.

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COMPANY.....

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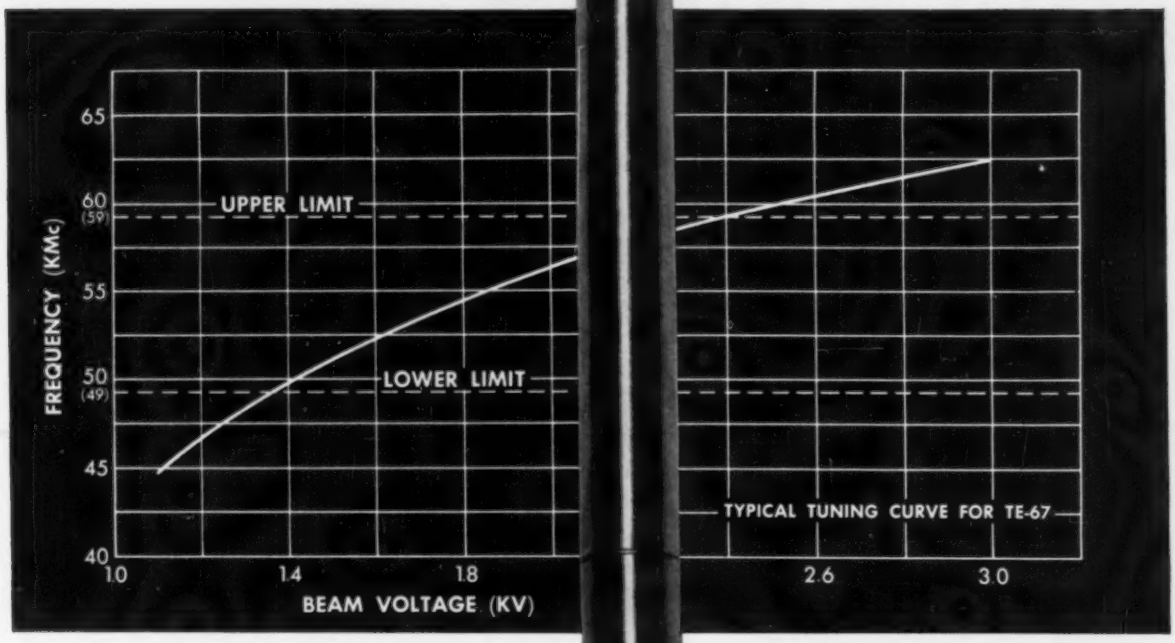
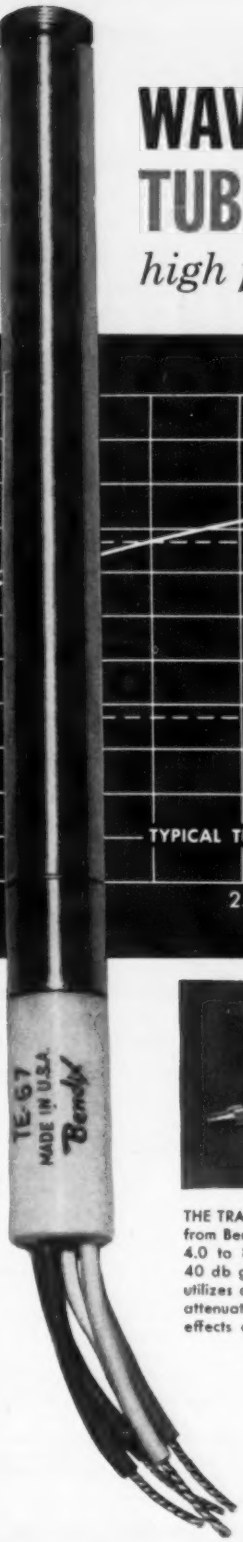
CITY.....ZONE.....STATE.....

New Bendix®

BACKWARD-WAVE OSCILLATOR TUBE

for extremely high frequencies





An exclusive Bendix Red Bank product, the Type TE-67 Backward-Wave Oscillator Tube generates microwave energy at extremely high frequencies never before available.

This new tube provides a wide range of usable frequencies for applications in: advanced types of multichannel telephone and television systems, high definition short-range radar, highly directive communications, microwave spectroscopy and other fields where low power, voltage-tuned millimeter wavelength radio frequency energy is required. As the backward-wave tube is voltage tuned, frequency is automatically changed by varying the voltage input. No mechanical tuning adjustment is required.

For more detailed information on the tubes described here, write to: RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

ELECTRICAL DATA

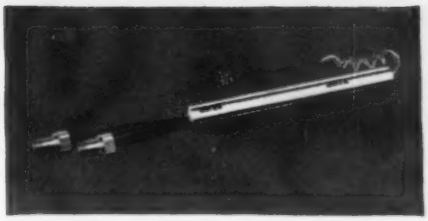
Frequency Range	49kmc—59kmc
Anode Voltage	1000—3000 volts
Power Output	5mw average
Beam Current	5ma
Magnetic Field	1300 gauss (minimum)
Heater Voltage	6.3±10%

MECHANICAL DATA

Output Flange	Special adapter to RG-98/U
Maximum Diameter	0.625"
Length	8"
Mounting Position	Any
Weight	5 oz.*

*Without magnet (tube only). Magnets are available.

Additional tubes are under development to extend the frequency range to 75 kmc.



THE TRAVELING-WAVE AMPLIFIER TUBE, also available from Bendix Red Bank, is designed for operation in the 4.0 to 8.0 kmc frequency range with approximately 40 db gain and 200 milliwatts output power. The tube utilizes a helical slow-wave structure with coupled helix attenuator section. The mechanical design minimizes the effects of vibration upon the tube operation.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif. • Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Distributor: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ontario

Red Bank Division

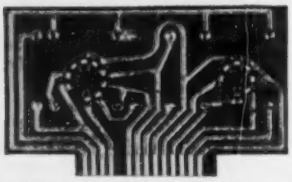
Bendix AVIATION CORPORATION

←CIRCLE 28 READERS SERVICE CARD

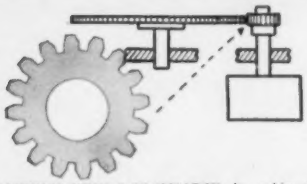
CIRCLE 29 READERS SERVICE CARD

glass-base laminates?

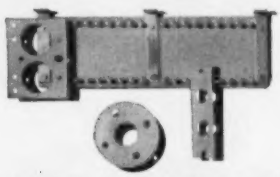
C-D-F DILECTO®
is the answer!



SPEED AUTOMATIC PRODUCTION of printed circuits with warp-resistant C-D-F metal-clad Teflon* and epoxy laminates. Other advantages: high bond strength of copper to laminate, superior blister-resistance in solder immersion.



HIGH-VOLTAGE (1800v.) RF ISOLATION is achieved by miniature C-D-F Dilecto gears in an aircraft receiver-transmitter switch. They also had to exhibit dimensional stability through a wide temperature range, resistance to fungus growth and thermal shock.



PRECISE MACHINING AND FABRICATION are standard benefits of Dilecto laminated plastics. These silicone glass-base parts (coil mountings, aircraft terminal board) were sawed, drilled, punched, and milled in production quantities by C-D-F and customer.

Teflon*, silicone, epoxy, melamine, and phenolic glass-fabric laminates. Polyester glass-mat laminates.

You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine can also be made with glass-mat base.) And C-D-F offers modern machining and fabrication facilities to deliver production quantities of finished Dilecto parts to your specifications.

See our catalog in Sweet's Product Design File, where the phone number of your nearby C-D-F sales engineer is listed. For free trial samples of glass-base Dilecto, or of any other C-D-F plastics, mica, or fibre product, send us your print or your problem! Write for your free copy of C-D-F Technical Bulletin 64.

*DUPONT TRADEMARK FOR TETRAFLUOROETHYLENE RESIN

PROPERTIES OF SOME TYPICAL C-D-F DILECTO GLASS-BASE GRADES

Grade	Equivalent NEMA or ASTM grade	Flexural Strength Lengthwise (PSI)	Dissipation Factor at 10^{6} ∞ Cond. A	Dielectric Strength Parallel Step x step	Insulation Resistance Cond. C96/35/90	Arc Resistance (seconds)	Maximum Operating Temp. (°C.)
GB-112T (Teflon*)	None	14,000	0.0015	65	100,000	180 +	250
GB-12S (Silicone)	G-7	28,000	0.002	60	100,000	180+	200
GB-28E (Epoxy)	G-10	70,000	0.019	65	75,000	130	150
GB-28EFR (Flame-Retardant Epoxy)	G-10	68,000	0.010	65	100,000	180	150
GB-28M (Melamine)	G-5	50,000	0.014	50	100	185	135
GB-261D (Phenolic)	G-1 and G-2	22,000	0.020	55	10,000	5	150
GM-PE (Polyester)	GPO-1	35,000	0.020	70	200	130	150

These are typical grades for typical applications. To meet special requirements, C-D-F makes many other Dilecto grades, one of which may serve your purpose better than any of these listed here. Consult the C-D-F Technical Department for expert assistance with your design problem involving laminated plastics products.

CDF

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DELAWARE

CIRCLE 30 READERS SERVICE CARD

CIRCLE 31 READERS SERVICE CARD →

Guaranteed, long-term accuracy 1%

AvoMeter 8 is unlike any test meter you have ever used. Compare it only with a laboratory standard . . . for both are hand-calibrated, with long-term accuracy conservatively specified . . . and guaranteed.

In ruggedness, portability, ease of operation, and, most important, in versatility, the AvoMeter 8 is superior even to the most costly standards.

Wherever you require an accurate, dependable multi-range meter, use the AvoMeter 8, moderately priced at $89.01.

Accuracy: 1%-DC current, 2%-DC voltage, 2½%-AC current and voltage. **Guaranteed.**

Sensitivity: 20,000Ω/v DC, 1,000Ω/v AC.

Hand Calibration assures maximum accuracy throughout every range.

Mirrored Scale and knife edged pointer prevent parallax errors.

Overload Protection by automatic cutout.

AC Current Ranges from 100 ma to 10 amps, full-scale.

Reversing Switch ends lead changing on signals of slowly varying polarity.

Zeroing Controls for each resistance range permit changeover without resetting.

Accessories extend ranges to 25,000 volts DC, 400 amperes AC, .025 ohms to 200 megohms resistance.

Price $89.01

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LORAN has long been recognized as the reliable, highly accurate system of long range navigation. LORAN is already implemented and in service over North Atlantic and Pacific air routes, with immediate expansion planned to cover other important areas, too.

Now, LORAN becomes an even more practical navigation system, with the development by Edo of a simplified, lightweight, *pilot-operated* unit. This compact equipment, weighing only 26 pounds installed, can be mounted in the cockpit. From it the pilot obtains directly read line-of-position information, without having to consult tables or make complicated calculations.

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EDO AIRBORNE LORAN, Model 345
Control panel and 3-inch scope are mounted in cockpit for operation by pilot or co-pilot. Receiver (left) occupies ¾ ATR rack. Installed weight of complete system is only 26 lbs., and compact unit requires only a small fraction of space formerly required. Designed and manufactured by Edo, a major supplier of advanced electronic systems for the U.S. Navy—sonar, radar, ASW equipment.

For the complete data on Edo Model 345 Airborne Loran, send for Technical Manual #501, Dept. T-8.

EDO Corporation
College Point, Long Island, New York

Manufacturers of a Trusted Line of Marine and Airborne Electronic Equipments

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and lock with thumbscrew on back.

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Since the basic movement accounts for the greater part of the meter cost—you can have a much more flexible inventory by stocking the minimum number of basic meter movements and a large variety and maximum quantity of the inexpensive Dial-Components.

Unimeter features are: self-shielded Bar-Ring movements: AC and DC linear scales • extreme accuracy • dustproof construction • error proof assembly • instant conversion • standard mounting.

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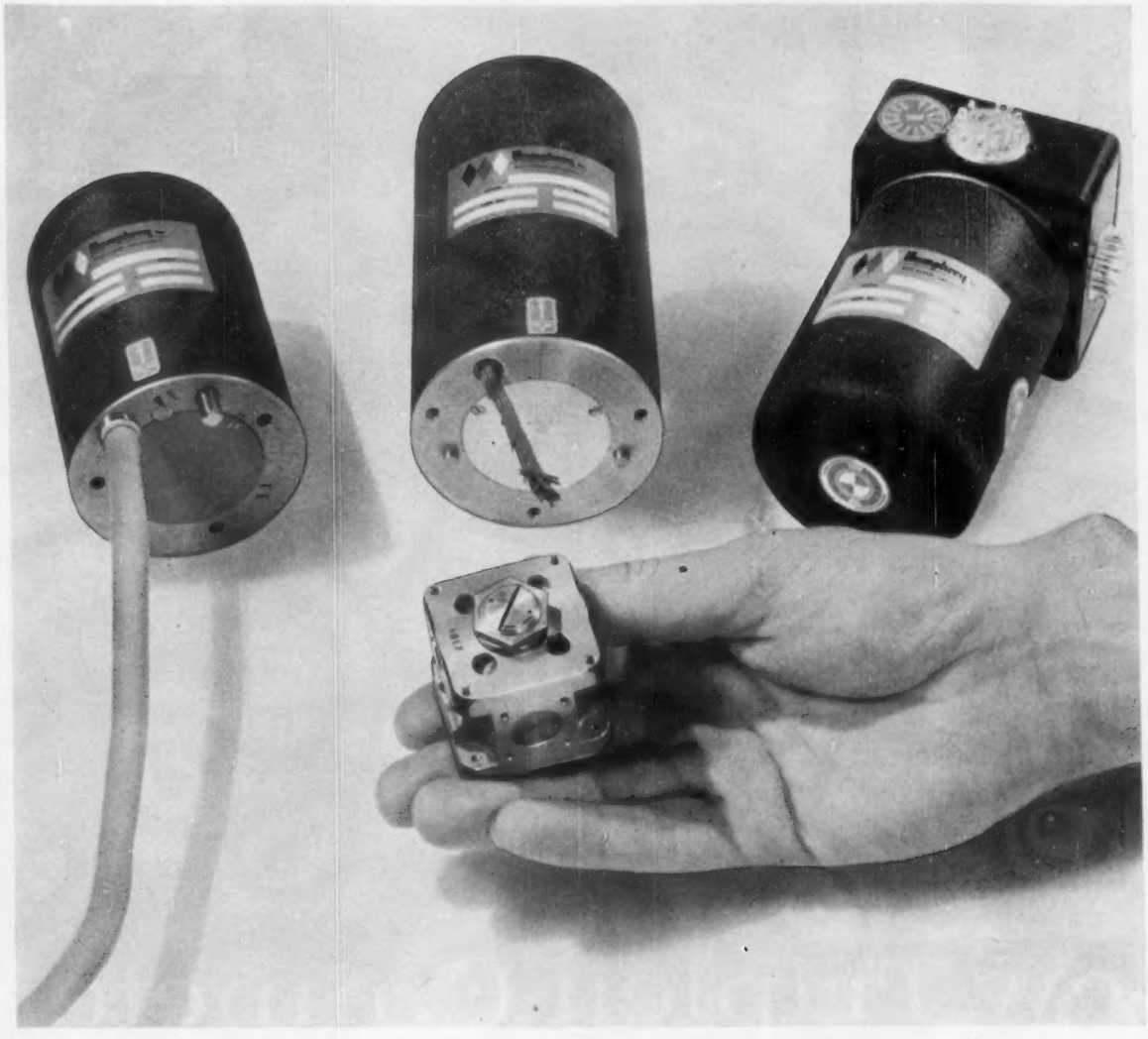
Three Standard Kits, too. Kit A (makes 8 ranges), Kit B (makes 12 ranges), Kit C (makes 23 ranges).



HUMPHREY FREE GYROS MAY BE POWERED BY D-C, 400-CYCLE A-C OR 1500-CYCLE INVERTER

New interchangeable motors for Humphrey free gyros now make it possible to select a gyro to operate on d-c, conventional 400-cycle a-c or 1500-cycle a-c power. Use of the small, high-speed wheel increases stability and reduces drift rate about one-half. High-speed motors may be operated on transistorized 1500-cycle power supplies, using readily available 6 or 28-volt d-c input.

Production gyros are offered with a variety of pickoff configurations, including potentiometer, synchro and switch type. Humphrey free gyros are available with a manual push-button cage, electrical uncage or with fully remote electrical cage and uncage with indicating or inter-lock switches. Whatever your position or angle sensing requirements, Humphrey has a free gyro that can do the job. Call or write today.

Humphrey Inc.
ELECTRO-MECHANICAL INSTRUMENTS

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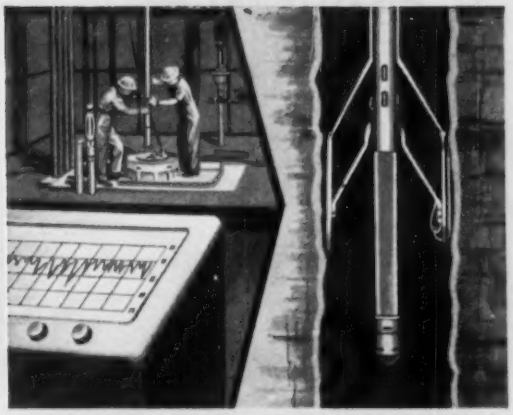
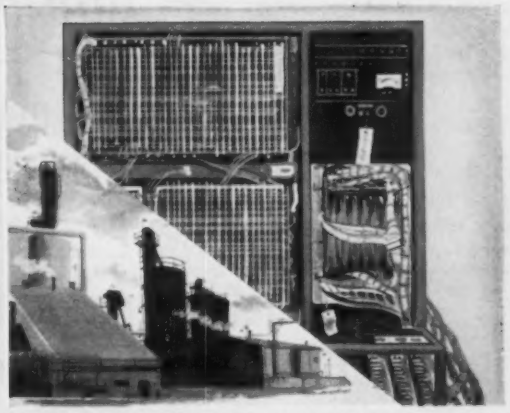


INSTRUMENTATION—In instrumentation, such as this geophysical measuring equipment, where miniaturization and resistance to environmental conditions are important, TFE resins are unsurpassed. They are unaffected by penetrating oils, heat, shock, vibration or resoldering; thermal and dielectric properties permit miniaturization, resulting in substantial space and weight saving.



PROCESS CONTROL EQUIPMENT—Process controls, instrumentation, and other industrial electronic equipment can be more reliable and more easily serviced at reduced costs with TFE resins. They have zero moisture absorption, are non-flammable, and are chemically inert. Neither potting temperatures nor soldering iron heat will damage TFE resins.

ELECTRONIC BUSINESS MACHINES—Non-flammability, safe emergency overloading, and solder resistance are three important reasons why TFE resins are used in machines such as this data-processing equipment. Servicing of wiring panels can be done quickly, with a minimum of downtime, because TFE resins are unaffected by soldering temperatures.

OUTDOOR EQUIPMENT—TFE resins are ideal for outdoor or underground wiring applications. They have unmatched insulation resistance, and are completely unaffected by exposure to salt water, sunlight, or other extremes of weather. Oil, gasoline, and other solvents have no effect on TFE resins, and they remain flexible in extremes of heat or cold.

For top performance in electronic circuitry specify wire and cable insulated with TEFLON TFE-fluorocarbon resins

Achieve utmost reliability and safety for your wiring. Reduce assembly and inspection costs. Cut weight and space requirements. These are a few of the advantages being realized by the use of wire and cable insulated with TFE resins.

TFE resins are almost ideal dielectrics, because they combine outstanding electrical and mechanical properties. They do not age, are non-flammable, have great flex life, maintain superior tear resistance, and display excellent dielectric properties.

Best of all, you can enjoy sales and cost advantages by using wire protected by TEFLON TFE-fluorocarbon resins.

Look up your local supplier in the Yellow Pages (under "Plastics—Du Pont") . . . or for technical information write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 178, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

▶ **Write for the "HOTTEST STORY IN WIRE INSULATION." It gives you the facts that can help make your design, your product, your installation—a winner.**

DU PONT REG. U.S. PAT. OFF. **TEFLON**® TFE-FLUOROCARBON RESINS

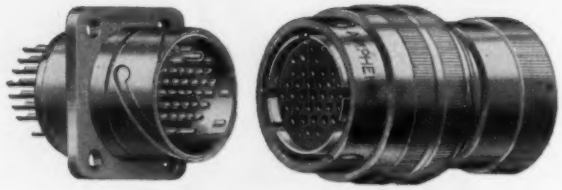
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

MINNIE CONNECTORS

pass tough, new ALTITUDE-MOISTURE RESISTANCE TEST salt water immersion, 65,000 feet altitude

AMPHENOL



Designers and manufacturers of aircraft and missiles, as well as the military, have long recognized the need for a connector altitude-moisture test which would accurately simulate actual performance conditions. Such a test has been developed by manufacturers and the military and applied as standard procedure on the 67 Series *MINNIE* connectors in the AMPHENOL Laboratories. It consists of the following:

A plastic tank is filled with distilled water and salt added to obtain a solution of 1.050 specific gravity. Marker dye is added for tracing leakage paths. The connectors are given a dry insulation resistance (IR) reading with a 500 volt megohm bridge. All coupling rings are then securely hand-tightened and grommet clamps rechecked for tightness. The connectors are then completely submerged in the salt solution so that all cable bundle ends are out of the solution. The ends of the cable bundle from one side of each connector are taped. The tank and connectors are placed in an altitude chamber and another IR reading is made.

The pressure inside the chamber is then reduced to 0.82 inch of mercury (80,000 feet altitude) and held for one minute, then increased to approximately 2 inches of mercury (65,000 feet altitude). After maintaining 2 inches of mercury for ½ hour, the chamber is returned to room ambient pressure for ½ hour. This is considered one complete cycle. Connectors are subjected to a total of 10 cycles.

At the conclusion of the tenth cycle, connectors remain completely submerged in the salt solution container at room-temperature and pressure for an over-week-end soak (65 hours). Final insulation resistance reading is then taken. Immediately after last IR measurement, specific gravity of salt solution is taken.

The "E"-type construction of AMPHENOL 67 Series *MINNIE* connectors was originally designed to meet the moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21. Since the development of the new and far more stringent altitude-moisture test, *MINNIE*'s construction design has been modified and all AMPHENOL *MINNIE* "E"-type connectors pass this test.

Following the altitude-moisture resistance test, insulation resistance measurements (in megohms) on production *MINNIE* "E" connectors were as follows:

Cycle	Insulation Resistance	
	Contact to Contact	Contact to Shell
0 (Initial)	6000	7000
1	7500	4000
2	5500	3200
3	5500	3000
4 (overnight 17 hour soak)	3000	1100
5	2800	1100
6	3000	1100
7	3000	1100
8	3000	1100
9	3000	1050
10	3000	1050
11 (overnight 17 hour soak)	2800	1000
12 (weekend 65 hour soak)	3000	1050

AMPHENOL *MINNIE* "E" connectors not only meet but surpass the requirements of this tough new test. 100 megohms is the minimum insulation resistance required by MIL-C-5015C after moisture; *MINNIE*'s minimum insulation resistance after immersion and altitude cycling is 1000 megohms.

67 Series *MINNIE* "E" Connectors

DESCRIPTION Miniature, multi-contact electrical connectors of the quick-disconnect bayonet lock type. Available as Plugs, Cable and Panel Receptacles, and Single Hole Mounting Receptacles. Shell design classes include:

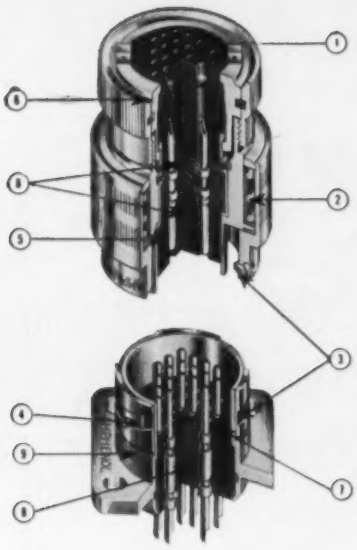
CLASS E—Environmentally resistant—individual wire seal
CLASS P—For potting
CLASS H—Hermetically sealed
CLASS J—For jacketed cable
CLASS C—Standard cable clamp

There are five shell sizes, and 17 insert arrangements—ranging from 3 contacts in the smallest to 48 contacts in the largest.

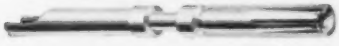
PART NUMBERING Descriptive part numbering of *MINNIE* connectors follows that used with AN (MS) connectors.

NOMINAL CURRENT RATING #20 contact is rated at 7.5 amperes and #16 contact at 17.0 amperes.

OPERATING TEMPERATURE −67°F. (−55°C.) to +257°F. (+125°C.).



HOODED SOCKET CONTACTS



Both #16 and #20 socket (female) contacts of AMPHENOL *MINNIE* connectors are resistant to test prod damage. The entering end of the socket has a one-piece hood that excludes the entrance of a pin 0.005" larger than the diameter of the mating pin. AMPHENOL Specification 340-43-2108, paragraph 4.5.14, gives this test to be used to determine resistance to test prod damage:

> *"A test prod of hardened steel having a diameter equal to a nominal mating pin shall be inserted into each socket contact to (a) .200 inch; (b) .255 inch; and (c) .310 inch depth. At each of these depths, measured from the face of the insert, a bending moment of 2 inch lbs. ±10 percent shall be applied to the 16 size contact prod and a bending moment of 0.8 inch lbs. ±10 percent shall be applied to the 20 size contact prod about the inserted ends of the prod. The connector shall be rotated in one direction through 360 degrees in order that a uniform force is applied to the inside surface of the socket contact. This test shall be performed with the socket contacts in the inserts and the contacts locked, if necessary, to prevent rotation in the inserts during the test."*

After withdrawal of the fixture at the completion of the above precedure, the force needed to engage or separate the socket contact shall not exceed the following values:

Contact	Max. Force Ounces	Min. Force Ounces
#20	12	2
#16	26	3

FEATURES OF AMPHENOL *MINNIE* CONNECTORS

(1) Environmentally sealed with unitized back end grommet. (Also available with provision for potting.) Grommet seal (type "E") meets altitude-moisture resistance requirements. Either grommet seal or potted seal meets moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21.

(2) Spring-loaded coupling ring provides a positive locking action in the bayonet slot, and a constant compensating force which eliminates the effects of resilient face seal compression set.

(3) Stainless steel bayonet slots and pins reduce wear and frictional characteristics and eliminate wear encountered with "hard-coat" and similar surface treatments of softer base metals. The three pin bayonet coupling minimizes the rocking action of the mated plug and receptacle.

(4) Flattened incline angle of bayonet slots reduces mating force requirement.

(5) Hooded contacts resist test prod damage as defined in Paragraph 4.5.14 of AMPHENOL Specification 340-43-2108.

(6) Unitized grommet seal; clamp and grommet form a single unit for ease of assembly and maintenance.

(7) Face seal gasket with individual barriers to isolate each contact.

(8) Hard insert dielectric (plus resilient face seal) positively retains contacts with no possibility of contacts being pushed out of the insert.

(9) A visual full engagement indicator is included in the design to insure the user that he has fully engaged the connectors. The indicator is an orange line around the receptacle shell.

- Insulation resistance of "E" type following altitude-moisture resistance test is a minimum 1000 megohms. MIL-C-5015C minimum following type "E" test is 100 megohms.
- When using mated sealed connectors, no derating for altitude is necessary at 70,000 feet.
- Test voltage 1,500 volts RMS 70,000 feet on sealed connectors.
- Vibration per Method 204 of MIL-Std-202A. 10 to 2,000 cps at 20 g's.
- Temperature cycling range per MIL-C-5015C, Paragraph 4.5.3 increased to 257°F. maximum and −67°F. minimum.

VOLTAGE RATING

	Rating	Mechanical Spacing (Nominal)	Flashover V-Rms	Test V-Rms	Recommended Working Voltage DC	Recommended Working Voltage AC
Sea level (unsealed)	A	.034	2,000	1,500	700	500
	B	.046	2,300	1,800	840	600
Sea level (sealed)	A	.034	2,500	2,000	700	500
	B	.046	3,000	2,500	840	600
70,000 ft. (unsealed)	A	.034	500	375	175	125
	B	.046	600	450	210	250
70,000 ft. (sealed)	A	.034	2,500	1,500	700	500
	B	.046	3,000	1,800	840	600

Send for your copy of the MINNIE catalog to obtain complete information.

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1830 S. 54th Ave., Chicago 50, Illinois

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Veeder-Root Panel-Mounted High Speed Electrical Counters

...with electric resetting in 1/10th of a second

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U. S. Air Force personnel remove 25,137 hour klystron from advanced Pole Vault base. Department of Defense Photograph.

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After 25,137 hours on the air, and still in perfect operating condition, this Eimac 3K50,000LF UHF klystron has been acquired through the cooperation of the U.S. Air Force and Canadian Marconi, Ltd. This klystron was one of the original tubes installed in Project Pole Vault, the first tropo-scatter communications line ever established. The tube is just one of a number of Eimac klystrons that have exceeded 25,000 hours of reliable on-the-air time in this system. Eimac klystrons are used as final amplifiers in the Pole Vault 10 kilowatt transmitters that handle multiple-channel voice and teletype communications. Experience with this first system in our early warning defense network confirmed klystron-powered tropospheric scatter as an outstandingly dependable system of long distance communication.

The exceptional performance of these tubes under the difficult logistical and environmental conditions of the far north is indicative of the reliability and conservative rating of performance-proved Eimac external-cavity klystrons. Eimac amplifier klystrons are now being used extensively for tropo-scatter communications throughout the United States, Canada and other regions of the world. Eimac klystrons for communications and pulse applications are now available covering frequencies from VHF to SHF and to multi-megawatt output powers.

For further information, write for a copy of the 24-page booklet "Klystron Facts Case Five."

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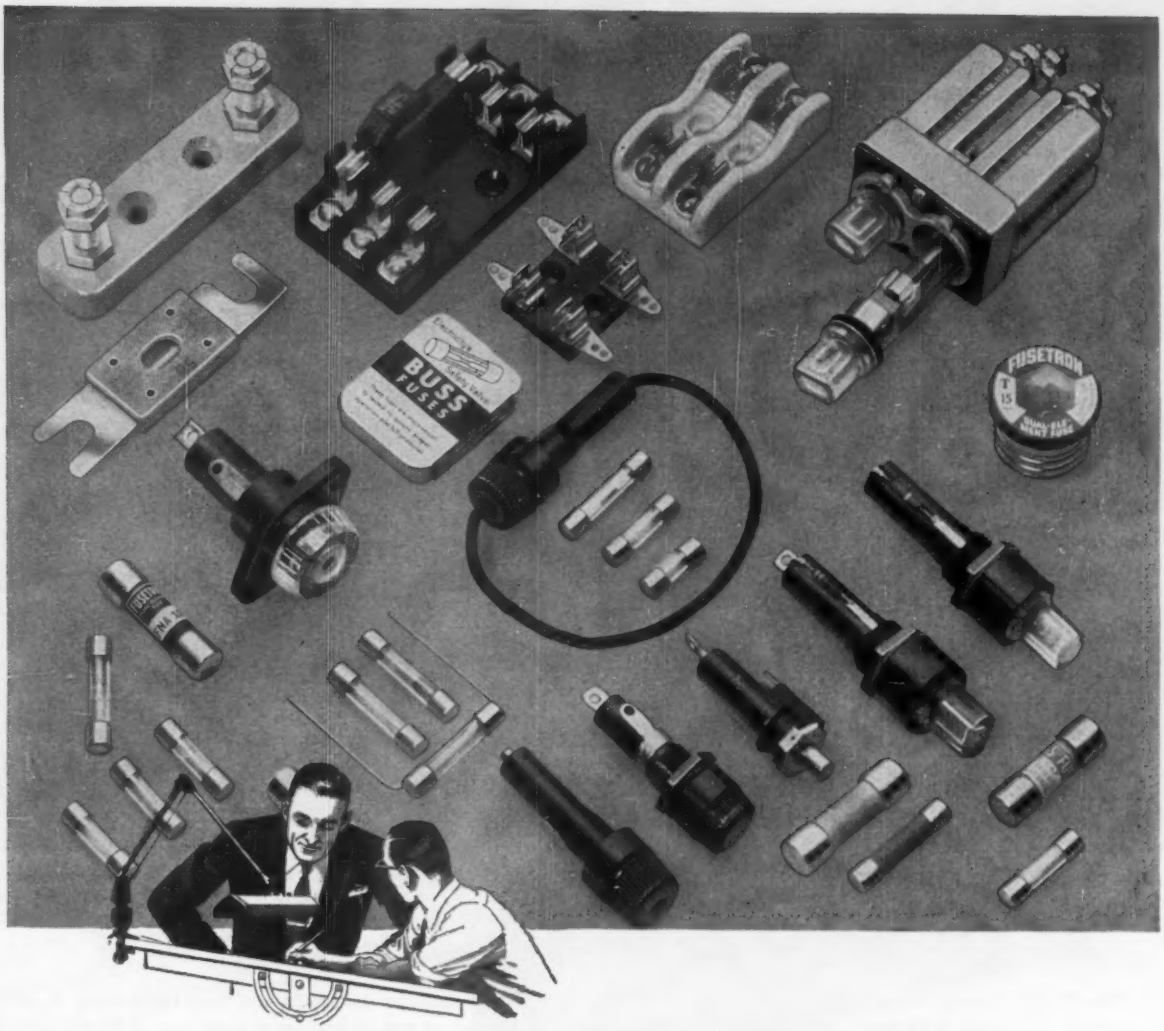

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To make sure of proper operation under all service conditions . . . every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

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accuracies to ±.01%, −55°C to +85°C
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accuracies to ±.001%, zero°C to +75°C
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SHOCK: *15 G's 11 milliseconds*

VIBRATION: *while operating,*
.5" displacement to 7.5 cps, 1.5 G's from 7.5 to 22 cps, .06" displacement 22 to 80 cps, 20 G's from 80 to 2,000 cps.

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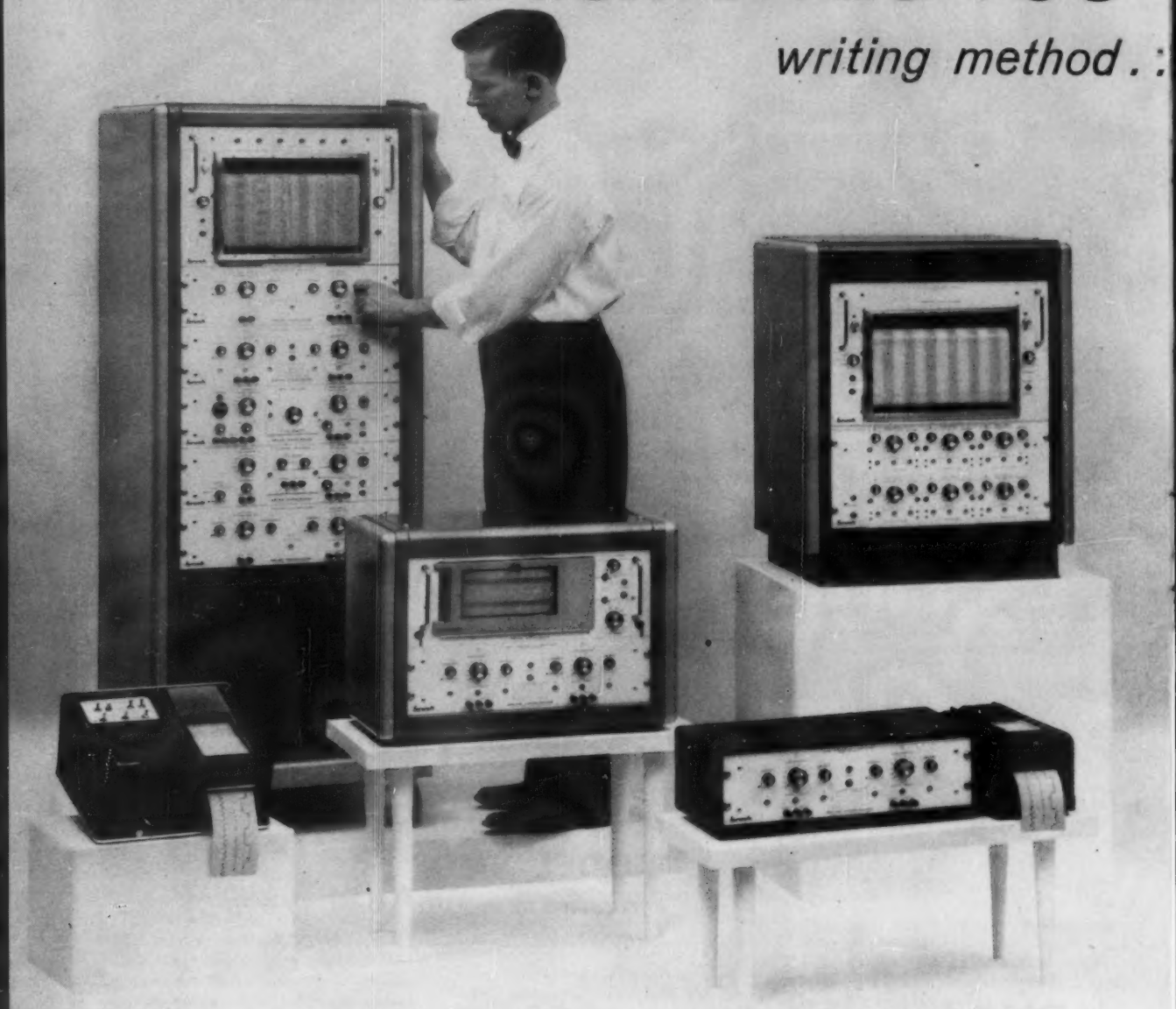

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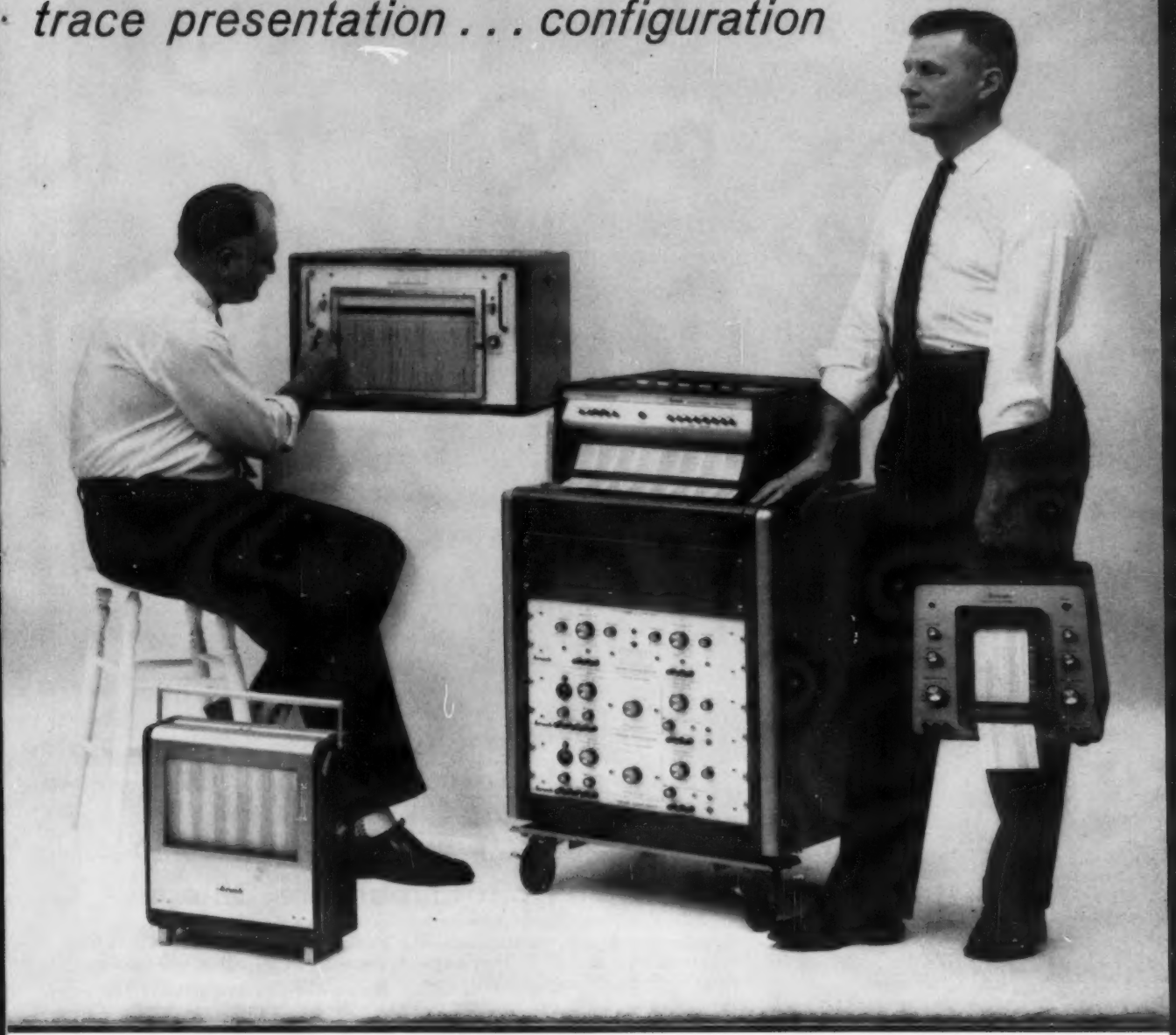
FREEDOM OF CHOICE

trace presentation . . . configuration



transmissions permit instantaneous switching on the spot or by remote control.

New functionally designed control panels are clean, legible, easy to understand. All components are readily accessible for fast inspection and simple adjustment.

The most comprehensive operating manuals in the industry are included with every Brush product.

Factory branches, service and warehousing at Arlington, Va., Cleveland and Los Angeles; engineering representatives in all key locations.

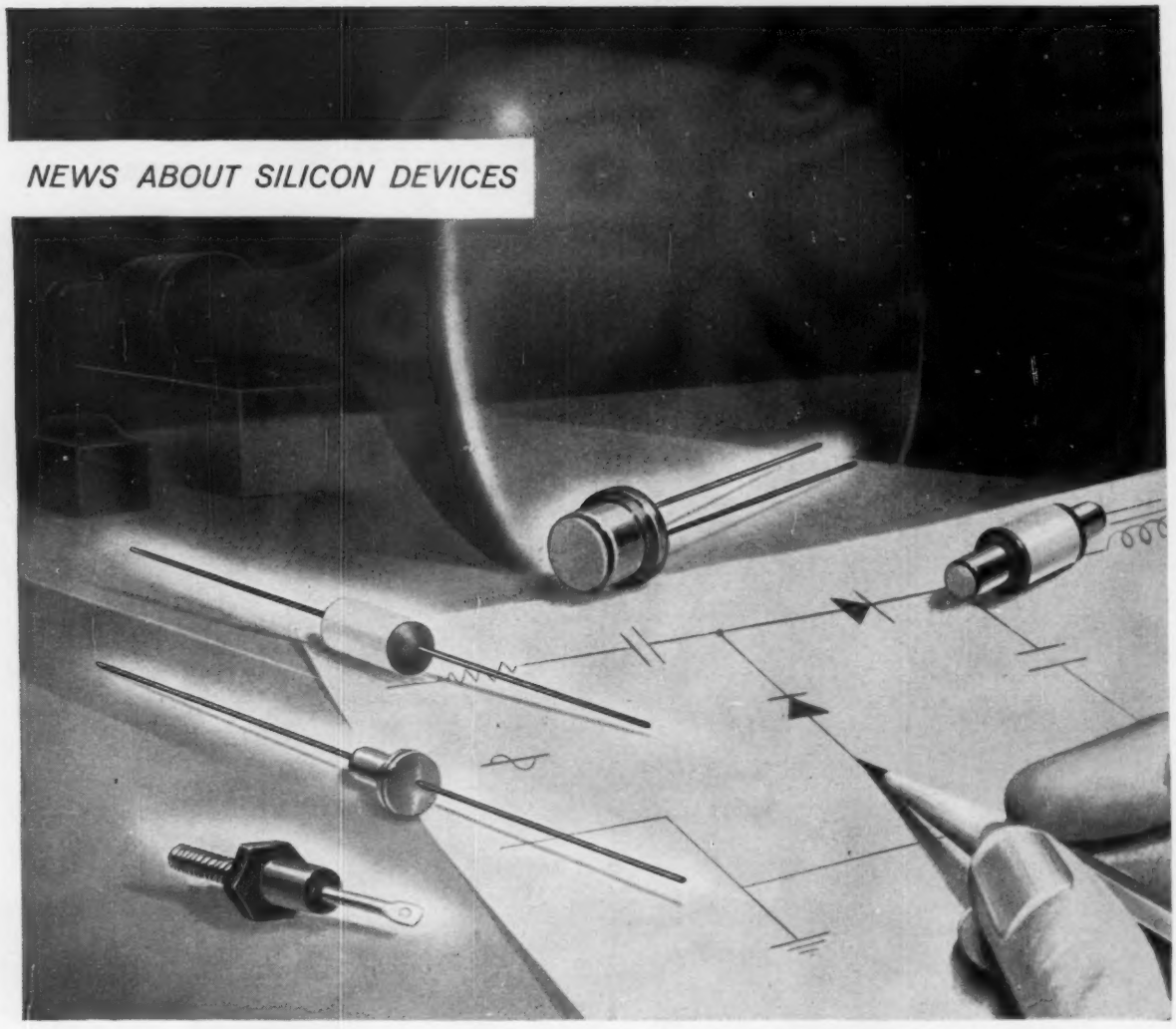
brush INSTRUMENTS

DIVISION OF CLEVITE CORPORATION

3405 PERKINS AVENUE CLEVELAND 14, OHIO

CIRCLE 43 READERS SERVICE CARD

NEWS ABOUT SILICON DEVICES



Reverse current: 10^{-7} amp. Rectification ratio: 10,000,000:1

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies . . . savings in space and weight . . . important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Silicon components can operate in ambients from –65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps. and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use . . . with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont . . pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

PIGMENTS DEPARTMENT

DU PONT HYPERPURE SILICON

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . *THROUGH CHEMISTRY*

CIRCLE 44 READERS SERVICE CARD

CIRCLE 45 READERS SERVICE CARD →

Reliability

Yarn control of the Cobble Bros.' Tufting Machine is through electrical contact fingers which transmit impulses to 120 CLARE RELAYS each controlling two electro-magnetic clutches.

That's why

COBBLE BROS.' controls were designed around Clare Relays

"The most important reason Clare Mercury-Wetted-Contact Relays were chosen as the basic components for this control is their *reliability*."

Assurance of billions of trouble-free operations caused engineers of Cobble Bros. Machinery Co. to design their electrical control system around Clare HG relays.

There are 120 Clare HG Relays in controls of the Cobble Yardage Tufting Machine shown. They receive impulses from 120 electrical contact fingers as they "read" the pattern. The relays operate electro-mechanical clutches to translate these impulses into intricate carpet designs.

Reliability means freedom from costly maintenance. If, like Cobble Bros.' engineers, you want only the best for your design, let us tell you ALL about Clare Mercury-Wetted-Contact Relays. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

Each relay is housed with a transistor in this modular type unit. The module is then plugged into the control system.

• • •

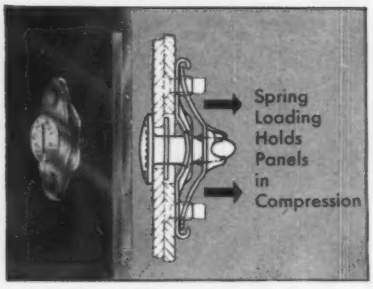
Send for Clare Bulletins 120 and 122

Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

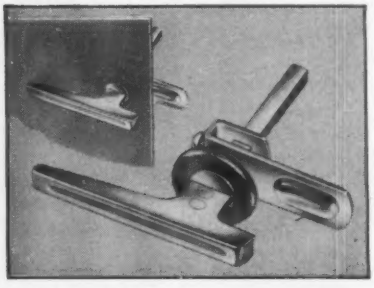
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)



Quarter-Turn Fastener

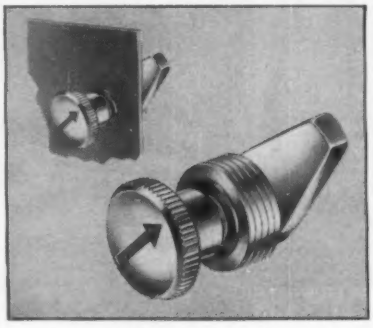
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.



Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place. No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

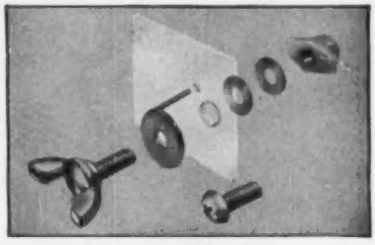


Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.

Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 8, just released. Gives complete engineering data on these and many other special fasteners. Forty-eight pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS

LION

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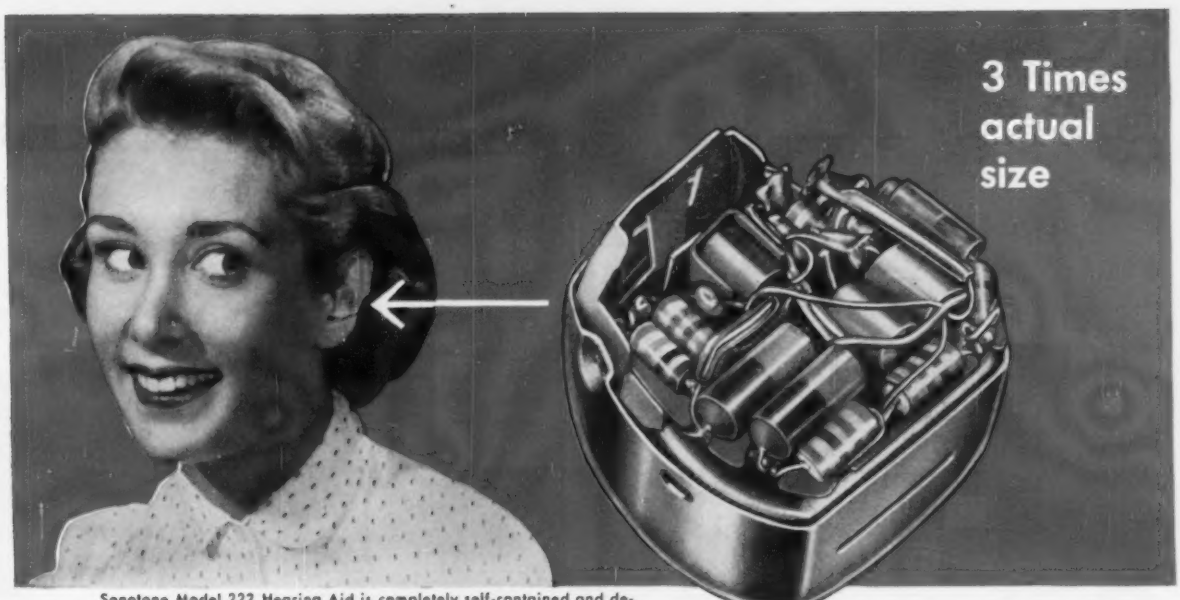
* *Quotation from "Designing Electronic Equipment for Maintainability"; Machine Design, July 12, 1956.*



Sonotone Model 222 Hearing Aid is completely self-contained and designed to be worn and supported entirely within the ear. Eight A-B Type TR, 1/10-watt resistors are used in the three-transistor amplifier.

SPACE PROBLEM SOLVED

with ALLEN-BRADLEY Hot Molded Resistors

Your space problem may seem impossible, but—try Allen-Bradley Type TR resistors. You'll be able to trim space requirements *way* down . . . with *no* sacrifice in quality or reliability. These unbelievably small composition resistors are made by the same basic hot molding process as is used for the larger Allen-Bradley resistors . . . assuring complete freedom from catastrophic failures. The Type TR resistors have an insulating coating that will withstand a continuous maximum voltage of 200 volts d.c.

Where higher ratings are needed . . . and quality is important . . . it's still Allen-Bradley! These larger sizes have an insulating jacket that eliminates the need for impregnation . . . yet provides reliable protection against long periods of high humidity.

Allen-Bradley makes other space-saving components, too . . . including hermetically sealed resistors, variable resistors, capacitors, and filter elements . . . all built to Allen-Bradley's *quality* standards. For detailed specifications and application data send for Publication 6024.

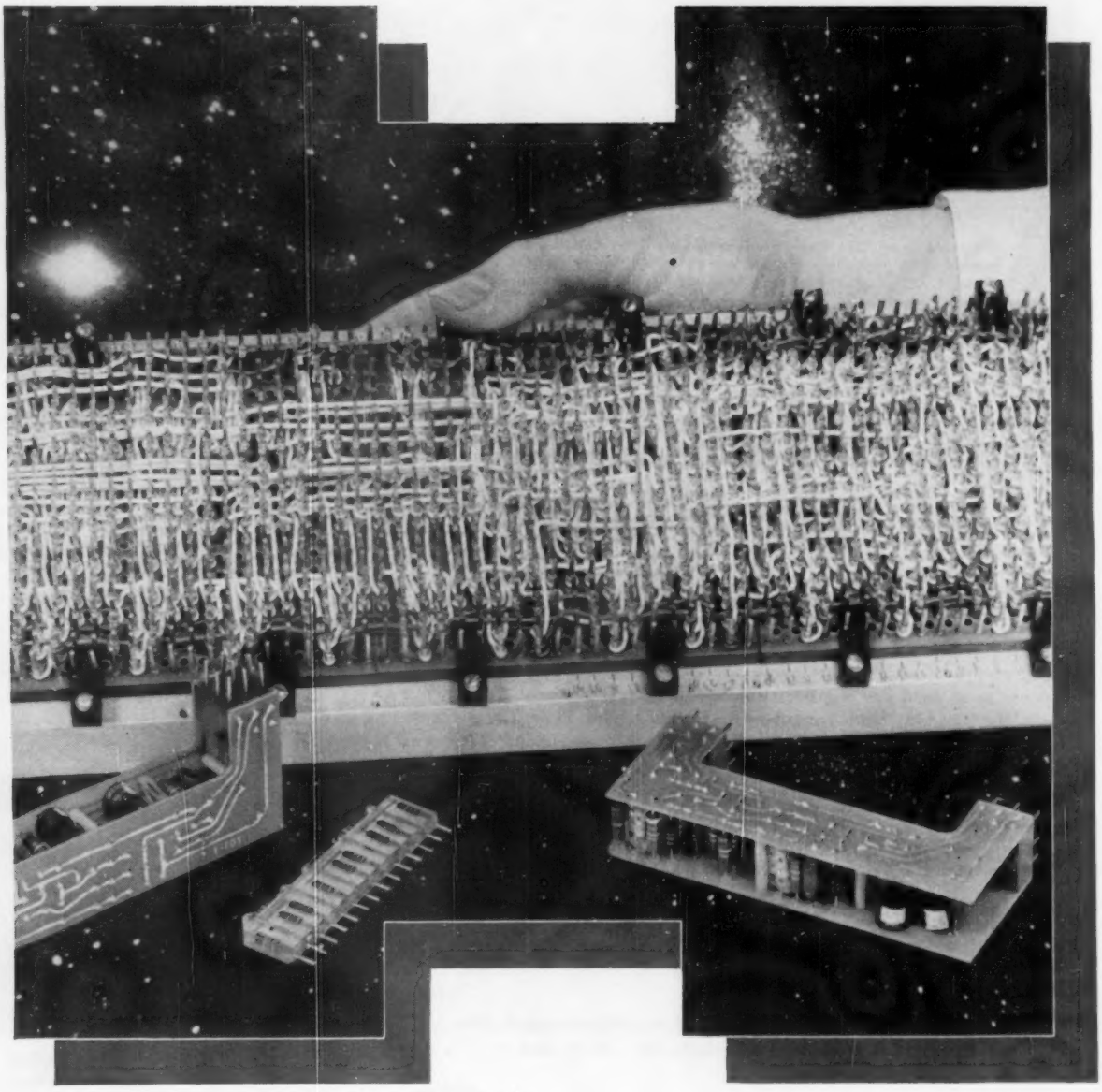
Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Actual Sizes

ALLEN-BRADLEY
QUALITY
ELECTRONIC COMPONENTS

A-B QUALITY

LIFELINE FOR



THE LEAP INTO OUTER SPACE

Our only link with outer space is the advanced Communications System. Our progress in space technology has become dependent on solving the vast network of new problems which the Space Age has imposed on the field of Communications.

To meet these problems the Hughes Communications Systems Laboratories is drawing upon its continuing efforts in the field of Global Airborne Communications. Such newly devised Hughes hardware, at left, for example, illustrates the use of high-reliability wire wrapping to replace soldered connections and the use of inexpensive miniaturized "cordwood" circuit modules to make possible high component density.

New methods, such as Hughes-pioneered digital techniques, are being formulated to achieve the long-range goal of developing communications systems capable of deflecting their signals from meteors, artificial satellites, and even the moon. Still other methods are being developed for systems which will transmit intelligence through media impervious to radio frequencies by modulating frequencies far up the electromagnetic spectrum.

Advanced thinking, diversification, and expansion are also taking place in other areas of the Research & Development Laboratories, of which Communications is a part . . . in Hughes Products, the commercial activity of Hughes . . . in Hughes Fullerton, where three-dimensional radar systems are under development . . . in Hughes El Segundo, the manufacturing facility for complex electronics systems . . . and in Hughes Tucson, where guided missiles are manufactured.

Never before have the opportunities at Hughes been more promising!

New commercial and military contracts have created an immediate need for engineers in the following areas:

Nuclear Electronics	Field Engineering
Microwaves	Vacuum Tubes
Communications	Crystal Filters
Reliability	Systems Analysis
Circuit Design	Computer Engineering

Write in confidence to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-W, Culver City, California.

Electromagnetic positioning of cutting edges is directed by this etched metal bar, a significant innovation which aided in the Hughes Products development of the first all-electronically controlled machine tool line.

Data processors under development at Hughes Fullerton will monitor the action of hundreds of aircraft and store the changing tactical situation in electronic memories for high-speed assignment of defense weapons. ►

the West's leader in advanced electronics

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton and Los Angeles, California
Tucson, Arizona

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Wescon show. Visit our booths 1401, 1402, 1812, and 1813 or the Hughes recruiting suites at the Chapman Park Hotel

MICRO SWITCH Precision Switches

NEW

Actual Size

We've Miniaturized the Subminiature!

WEIGHT: *1 gram . . . 28 switches to the ounce . . . over 430 to the pound.* SIZE: *.500" long, .200" wide, .350" high.*
CUBIC CONTENT: *.035 cubic inches.* ELECTRICAL RATING: *5 amps-250 vac, 30 vdc. SPDT.*

After a long period of laboratory development, MICRO SWITCH announces this new, highly miniaturized precision snap-action switch and a complementary line of actuators.

We call it the "Sub-subminiature!"

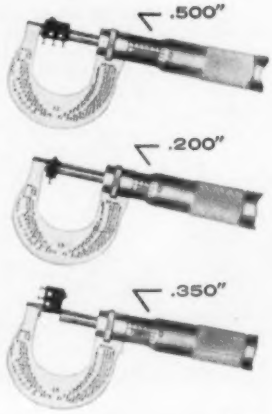
This new "SX" basic switch represents an entirely new set of answers to the space-weight problems in dependable precision switching. It combines new small size with more than ample capacity for wide usefulness, meeting the pressing demand for miniaturization combined with reliability.

In its exacting development, many problems of design, testing and quality control presented themselves. However, 23 years of experience proved of immense value. As a result, a new standard has thus been set by which all precision switches must be measured.

This broad experience can prove of equal value to you. Send for more information about this new switch. Request Data Sheet No. 148.

—•—

MICRO SWITCH...FREEPORT, ILL.
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario



Honeywell
MICRO SWITCH PRECISION SWITCHES

The two-word name MICRO SWITCH *is* NOT *a generic term. It is the name of a division of Honeywell.*

WHY IN THE WORLD

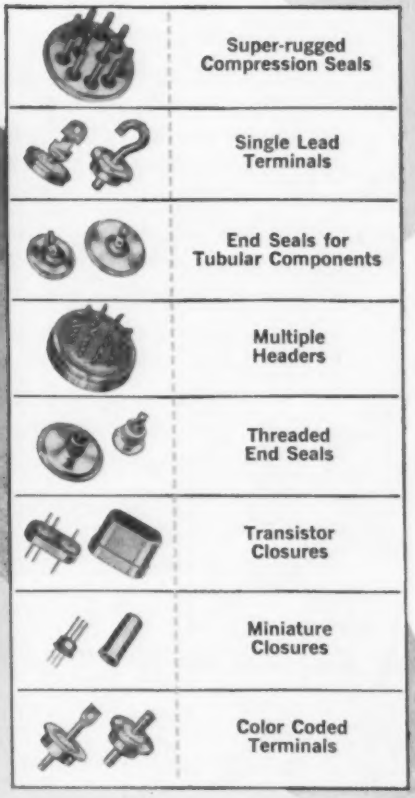
use E-I glass-to-metal* seals?

—A GOOD QUESTION, AND

here's the answer!

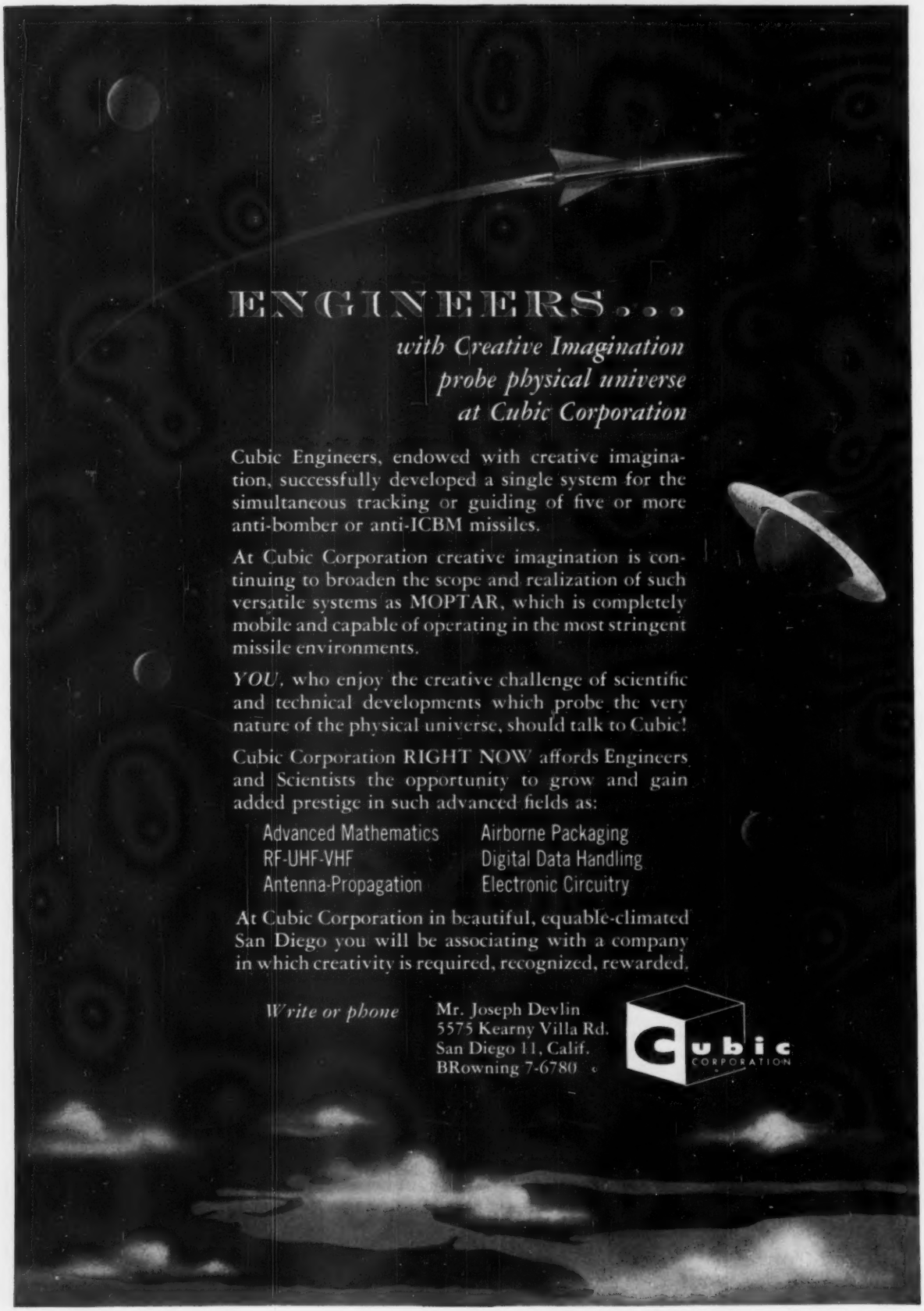
You can *always* depend on the leader—Electrical Industries glass-to-metal seals have been an industry standard since 1940. With research, development and manufacture devoted exclusively to the production of hermetic seals, E-I has the experience and facilities to solve your most difficult sealing problems.

The E-I standard line offers designers and engineers a choice of hundreds of types of seals that reflect the economies of mass production methods. In addition, E-I designs custom types for special applications, or will seal components of your manufacture. Call or write E-I for catalog, or send drawings for recommendations on your sealing application.



ELECTRICAL INDUSTRIES
A Division of Philips Electronics, Inc. • MURRAY HILL, N. J.

Patented in Canada, No. 523,390; in United Kingdom, No. 734,583; licensed in U.S. under Patent No. 2561520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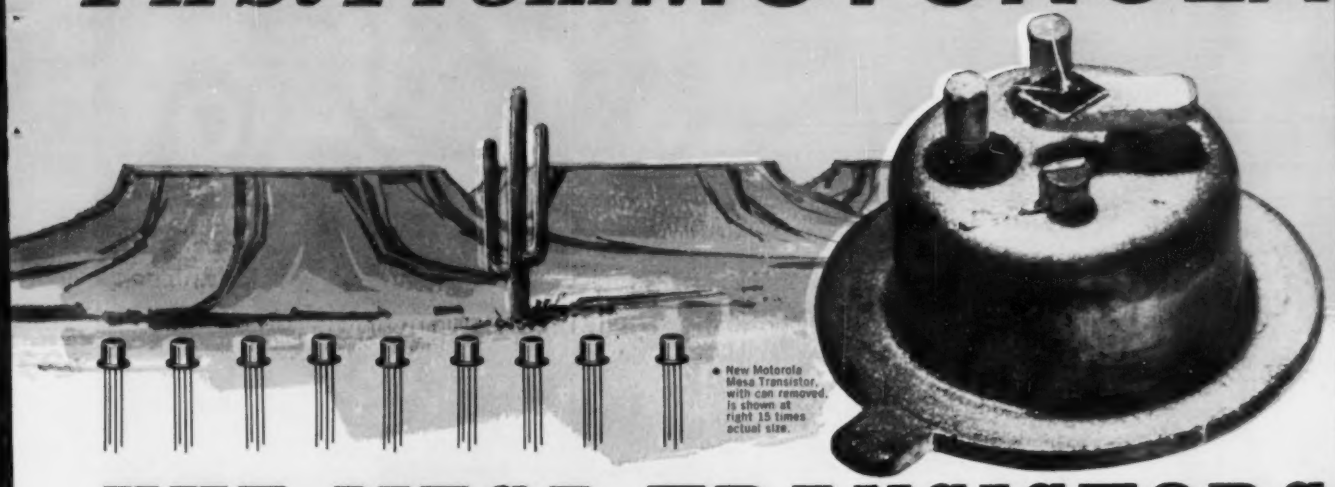
CIRCLE 53 READERS SERVICE CARD→

First From MOTOROLA



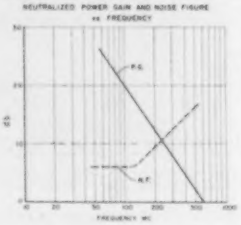
• New Motorola Mesa Transistor, with can removed, is shown at right 15 times actual size.

UHF MESA TRANSISTORS

2N700 LOW-NOISE HIGH-FREQUENCY AMPLIFIER					
TYPICAL CHARACTERISTICS					
TYPE	*f max*	*Power Gain*	BV_{cn} @ 100μa	*NF* @ 200 mcs	*Max Power*
2N700	600 mcs	12 db @ 200 mcs	33 volts	9 db	50 mw

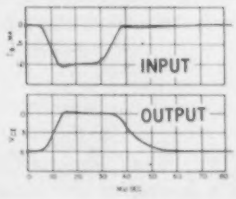
Operating Temperature
100°C case temperature with 12 mw dissipation
Germanium PNP

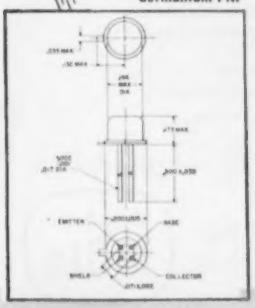
actual size



2N695 ULTRA HIGH-SPEED SWITCH					
TYPICAL CHARACTERISTICS					
TYPE	BV_{cn}	I_{co} @ 5 volts	β sat. at 20 ma	I_c max	P_c
2N695	20 volts	.8μa	30	20 ma	50 mw

Operating Temperature
100°C case temperature with 12 mw dissipation
Switching Times
in the order of 10 mμsec
Germanium PNP





FOR COMPLETE TECHNICAL INFORMATION
concerning Motorola Mesa Transistors contact the nearest Motorola regional office; or wire, write or phone
MOTOROLA, INC.,
5005 East McDowell Road, Phoenix, Ariz.
BRidge 5-4411 Teletype PX80.

the beginning of an exciting new transistor family

- Extreme reliability — only high temperature materials used, process carefully controlled.
- Higher operating temperatures.
- Rugged — withstands 50,000G acceleration.
- New header design provides effective interelectrode capacitance isolation . . . smaller inductance.
- Low nuclear radiation susceptibility.
- Modified JETEC 20 case . . . hermetically sealed.
- Meets or exceeds mechanical and environmental requirements of MIL-T-19500A.
- High uniformity — "Normal" instead of "selected" distribution.
- **A Revolutionary New Family**
These are only the first of a wide variety of germanium Motorola Mesa Transistors coming your way soon.

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Dr. Baller has been engaged in a wide variety of advanced engineering projects for 18 years. At General Mills he directs and coordinates activities of an excellent staff of unusually capable engineers. Dr. Baller is one more reason our customers say, "At General Mills, we get results."

Painting pictures, designing missile systems... creativity typifies the General Mills engineer

Meet Dr. Howard Baller, art collector, amateur painter, and Director of Engineering at the Mechanical Division of General Mills. At the office or at the easel, creativity is the mark of his endeavor.

This same creativity is the distinguishing feature of the well equipped, highly talented engineering department he directs. It is seen in every staff member—reflected in every one of their projects, some of which include . . .

SYSTEMS

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- Ground Support Equipment
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We team creative engineering with intensive research and fine precision manufacturing to serve the nation's most exacting customers. We'd like to serve you.

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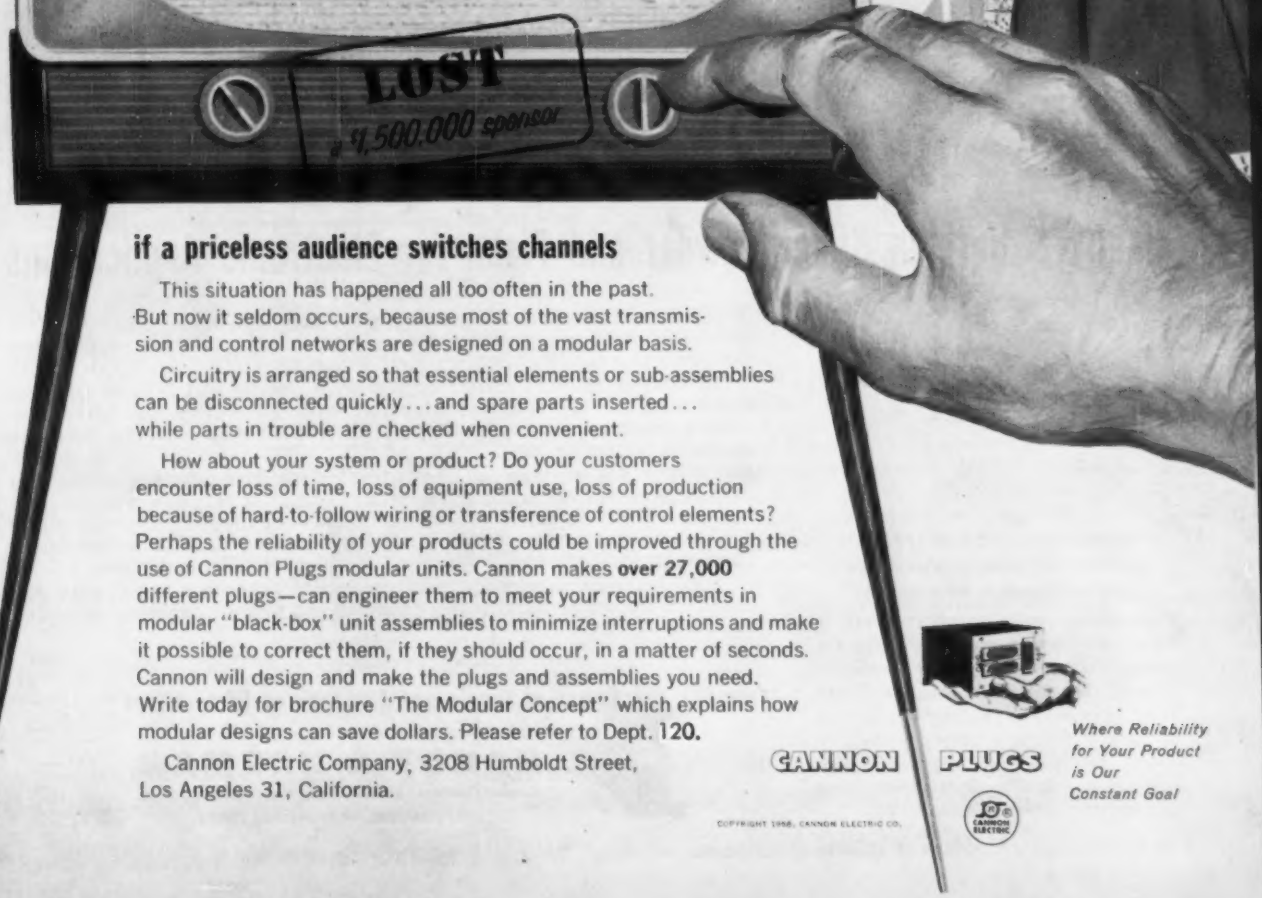
General Mills

CIRCLE 54 READERS SERVICE CARD CIRCLE 55 READERS SERVICE CARD→

INTER-RUPTED!



if a priceless audience switches channels

This situation has happened all too often in the past. But now it seldom occurs, because most of the vast transmission and control networks are designed on a modular basis.

Circuitry is arranged so that essential elements or sub-assemblies can be disconnected quickly... and spare parts inserted... while parts in trouble are checked when convenient.

How about your system or product? Do your customers encounter loss of time, loss of equipment use, loss of production because of hard-to-follow wiring or transference of control elements? Perhaps the reliability of your products could be improved through the use of Cannon Plugs modular units. Cannon makes **over 27,000** different plugs—can engineer them to meet your requirements in modular "black-box" unit assemblies to minimize interruptions and make it possible to correct them, if they should occur, in a matter of seconds. Cannon will design and make the plugs and assemblies you need. Write today for brochure "The Modular Concept" which explains how modular designs can save dollars. Please refer to Dept. 120.

Cannon Electric Company, 3208 Humboldt Street, Los Angeles 31, California.

CANNON PLUGS

Where Reliability for Your Product is Our Constant Goal

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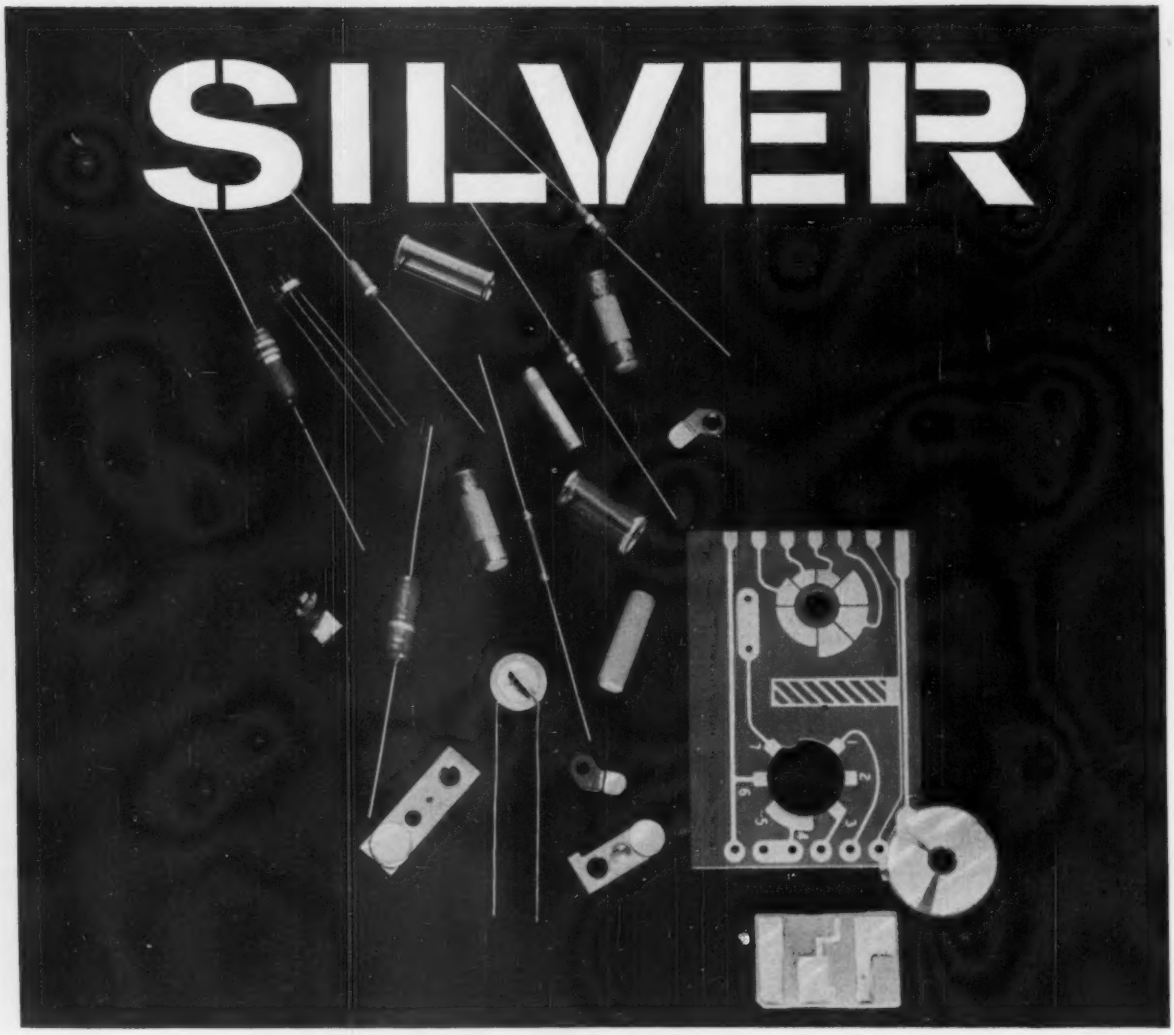

Handy & Harman Silver Powder and Flake for Electronic Applications

Among the many forms of silver and silver alloys manufactured by Handy & Harman are:

Fine silver (wire, strip and foil) • Silver anodes and grain for plating • Silver contact alloys • Silver powders • Silver flake, paints and paste • Silver brazing alloys • Silver electronic solders • Silver sintered metals • Solder-flushed silver alloys • Silver chloride and oxide • Coin silver (wire and strip) • Silver bi-metals

The increased acceptance of silver powder and flake in electronic circuitry and components has created a demand for a source that can supply these materials at a consistently high level of quality.

Handy & Harman manufactures silver powder and flake in all types and forms, for use in formulations on printed circuitry and wiring, resistors, condensers, thermistors, printed terminal strips on glass, ceramics or plastic laminates, etc.

If you are working on conductive or resistive coatings where you require excellent electrical conductivity, Handy & Harman will welcome the opportunity to assist you in the choice – or discussion of *any* silver product that may interest you. Write for Technical Bulletin A-4 on Silver Conductive Coatings and Bulletin A-5 on Silver Powder and Flake.

Our technical service and field application experience are at your disposal... we welcome inquiries on products and product problems involving any form of silver.

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NOW 99

Different Attenuators in The

PRD PACEMAKER LINE

LOOK down the line of these PACEMAKERS.

Diverse in function, they are all characterized by simplicity of operation, higher accuracy, greater strength factors . . . and low cost resulting from volume manufacturing. PRD is the largest maker of microwave instrumentation, the PRD PACEMAKER LINE is more complete than any other.

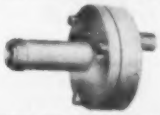
WAVEGUIDE ISOLATORS
See Catalog Page A-21

ROTARY STANDING WAVE DETECTOR
See Catalog Page B-13

DIRECTIONAL COUPLERS
See Catalog Page C-9

EXPANDED SCALE FREQUENCY METERS
See Catalog Page D-12

SPECTRUM ANALYZERS
See Catalog Page F-13



THERMISTOR AND BOLOMETER MOUNTS
See Catalog Page E-15

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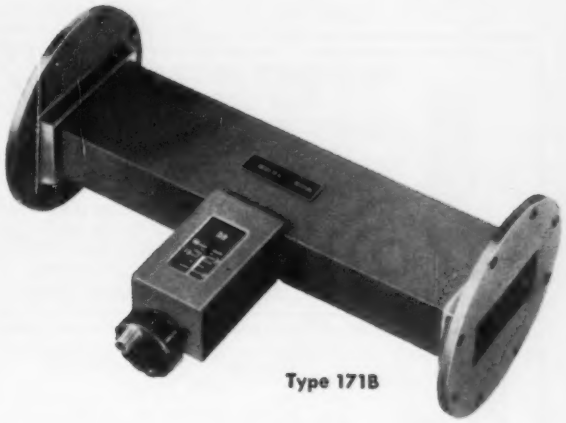

Type 171B

LEVEL SET ATTENUATORS

Designed for convenient adjustment of power level and for use as padding devices, these units cover the 2.6 to 18.0 KMC/s range. In each of these 6 standard waveguide sizes, a 20 db and 40 db attenuation range is offered. Well-shielded attenuation is achieved by means of a ruggedized, shock and moisture resistant element which is mounted parallel to the sidewall of the waveguide. Both ends of this element are matched to provide low VSWR (1.15 maximum). Smooth variation of attenuation is obtained by means of a low backlash, multi-turn drive. Approximate attenuation markings are provided on a scale which is calibrated near the center of the waveguide frequency range.

For complete specifications, see page A-17 of the NEW PRD *Catalog.*

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.
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FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

*3⅛" high
400 - 1000 cy.

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

*3½" high
400 to 500 cy.
optional

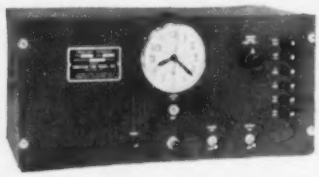
FREQUENCY STANDARD
TYPE 2005

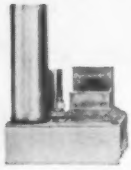
Size, 8" x 8" x 7¼" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007–6 (± .02% at —50° to +85°C)
R2007–6 (±.002% at +15° to +35°C)
W2007–6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)



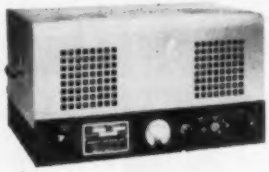


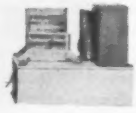
FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 211IC

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.





ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

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Watch Master
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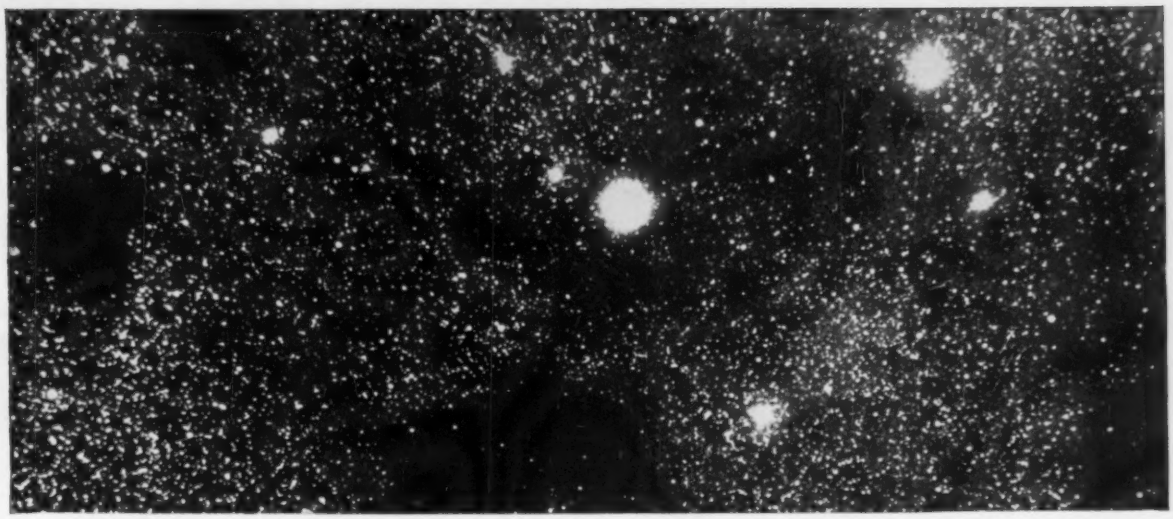
580 Fifth Ave., New York 36, N. Y.



Courtesy Mount Wilson Observatory

FROM BEYOND THE SKY TO BENEATH THE SEAS

In the field of communications, two extraordinary events have occurred within a short span of time. One was the linking of Europe to America by the submarine telephone cable. The other was the sending of radio signals from U. S. satellites in outer space.

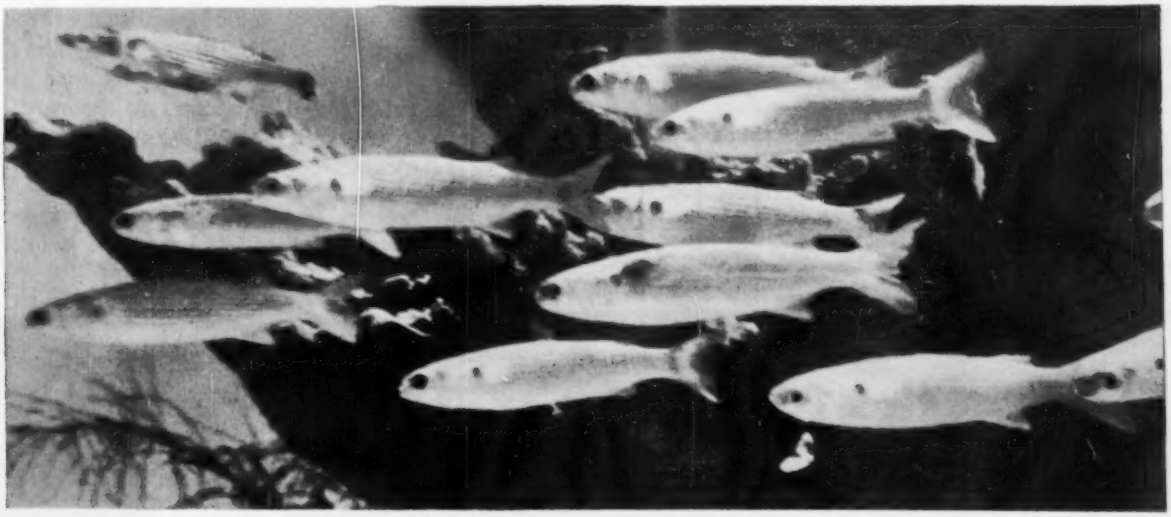
Both achievements depended on developments from Bell Telephone Laboratories. The cable was made possible by development of long-life electron tube amplifiers able to withstand crushing pressure on the ocean floor. The satellites derive their radio voices from transistors—products of basic research in semiconductor physics.

The deep sea amplifier and the transistor illustrate the wide range of work at Bell Telephone Laboratories. Here, over 3000 professional scientists and engineers explore and develop in physics, mathematics, electronics, chemistry, mechanical engineering, even biology—in every art and science which can help improve electrical communications.

Through this work, Bell Telephone Laboratories has helped make your telephone service the world's finest—and will keep it so.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



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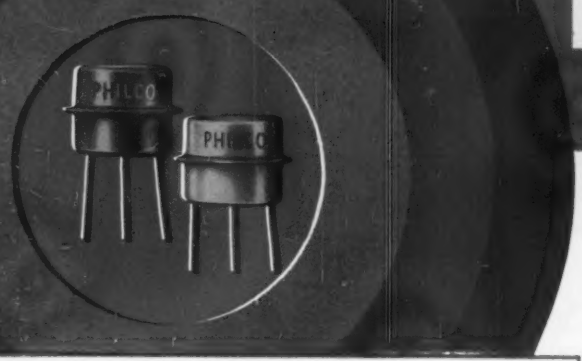
New Medium Frequency Transistor Family!



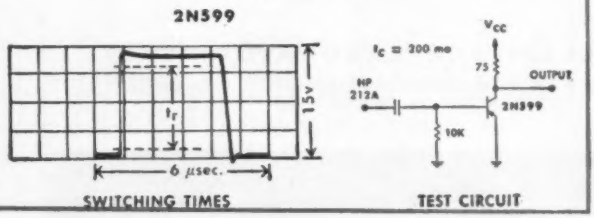
- **High Dissipation: 250 mw at 25°C**
- **High Current: Max. I_C = −400 ma**
- **High Temperature: 100°C Max.**
- **High Voltage: Max. V_{CB} = −30v**
- **High Frequencies: Min. $f_{\alpha b}$ to 12 mc**

PERFORMANCE DATA

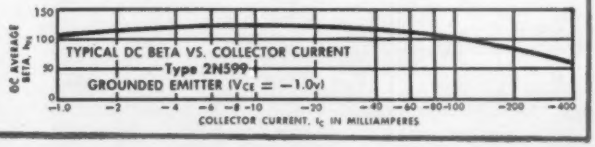
Type	General Performance: Minimum $f_{\alpha b}$	General Performance: Typical h_{FE}	Max. Ratings: I_C	Max. Ratings: V_{CB}	"ON" Switch Performance: Max. V_{CE}	"ON" Switch Performance: Max. V_{BE}
2N597	3 mc	V_{CE} = −1v, I_C = −100 ma 35	400	30	0.2	0.34
2N598	5 mc	V_{CE} = −1v, I_C = −100 ma 90	400	30	0.2	0.34
2N599	12 mc	V_{CE} = −1v, I_C = −100 ma 105	400	30	0.2	0.34

Total Device Dissipation at 25°C = 250 mw

TYPICAL RISE TIME CIRCUIT



TYPICAL DC BETA VS. COLLECTOR CURRENT



Announcing a new Philco family of PNP germanium alloy junction transistors (In TO-9 [JETEC 30-type] housing). These transistors feature a unique, patented, cold-welded *copper* housing and internal construction that result in lower junction temperatures at normal operating power levels. Design of the 2N597, 2N598 and 2N599 insures improved life and reliability at temperatures as high as 100°C. Available in production quantities.

The high beta of these transistors at high currents makes them particularly applicable to medium speed flip-flops, logic gates, drum writers and core-driver circuits. The 30v collector rating provides the high level logic swings required in many data processing equipments. At 200 ma of collector current typical rise time for the illustrated circuit is 0.05 μsec.

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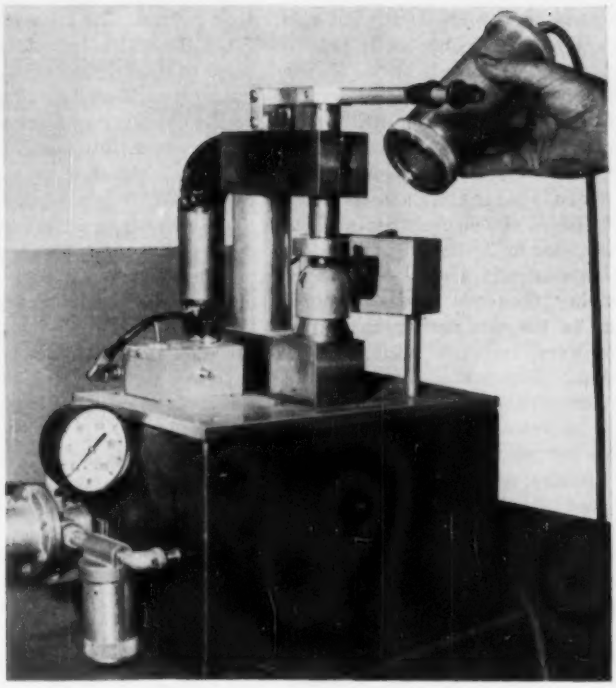
LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

electronics
engineering edition

AUGUST 15, 1958



As air motor spins high-explosive charge in magnetic field, a sensitive iron probe, rigidly mounted in the plane of the barrier, picks up variations in the flux pattern and determines the concentricity of an encapsulated piece of steel which plays a key role in controlling detonation pattern of explosive

Magnetic Gage Locates Encased Metal Parts

Magnetic-field pickup accurately locates the exact position of a ferromagnetic barrier encapsulated in a shaped-charge container. Principle is used to determine whether or not encased metal piece is off center, tilted or both. High-explosive charge containing barrier is used in oil-well blasting

By **PAUL SEAWARD,** Poulter Laboratories, Stanford Research Institute, Menlo Park, California

ACCURATELY LOCATING the exact position of a ferromagnetic object, solidly embedded in a casing, is accomplished by spinning the casing in a magnetic field and picking up small variations in the flux pattern of the encapsulated metal. Using this principle, it is possible to determine whether such an encased object is in its proper position, is off center, tilted or both.

The magnetic concentricity gage was developed to determine the exact location of a piece of steel which is encapsulated in a high-explosive charge used for oil-well blasting. In this application, it is essential to check the exact placement of the steel piece after the explosive charge has been loaded, for this curved steel barrier plays a key role in controlling the magnitude and direction of the high-velocity jet of metal discharged when the charge is detonated.

A photo shows the main unit of the gage. The meter, amplifier, and power supply are located in a special box attached to the outside of a building.

The shaped charge is held against the brass drive spindle by a brass idler shaft. Equally spaced numbers on the periphery of an aluminum indexing wheel, fastened to the brass idler shaft, are used with a flashtube circuit to indicate the direction of maximum eccentricity of the barrier. When the

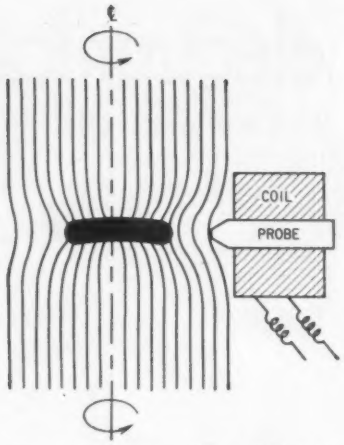


FIG. 1—Diagram clarifies principle involved in the detection of small variations in the flux pattern caused by spinning ferromagnetic object (black) in a magnetic field. The amount of eccentricity is exaggerated to emphasize the variation in flux lines

upper spindle engages the charge, an air motor is started and the upper end of the drive spindle, pressing against the copper cavity liner in the shaped charge causes it to rotate.

The spinning shaped charge, exposed to a magnetic field, produces a flux pattern. As the steel barrier rotates, possibly tilted or off center, flux variations induce a voltage in a coil that is wound around an iron probe and placed in the plane of the barrier and as close to it as practical. Figure 1 shows the principle. The signal voltage is amplified and not only gives a measure of the amount of eccentricity but also fires a flashtube once each revolution to give an indication of the position of maximum eccentricity.

The sensitive pickup coil probe consists of 22,000 turns of No. 36 enameled wire wound on a bobbin. The core is made from a $\frac{3}{32}$-in. stack of 0.014-in. silicon iron laminations $\frac{13}{16}$-in. wide by $3\frac{3}{8}$-in. long. The $\frac{1}{4}$-in. probe point width was achieved by shearing the ends of the laminations to the desired shape before they were inserted into the coil bobbin. The whole assembly is vacuum-varnished for rigidity. A rigid mounting is fabricated from hardwood pieces and heavy aluminum pillars, so that relative motion between pickup probe, rotating steel barrier and magnetic field is due only to the eccentricity of the barrier. A permanent magnet, made from two pole-pieces of a magnetron magnet, provides the magnetic field.

Measurements of the voltage, generated in the pickup coil by test pieces of known eccentricity, showed that the coil voltage was directly proportional to both the barrier offset and the barrier rotational speed. At 30 rps, approximately 6 millivolts per thousandth-in. offset was generated in the coil. This voltage is read on a vacuum-tube voltmeter.

The flashtube trigger circuit, Fig. 2, uses a 2D21 thyratron switch to discharge a capacitor across the primary of a high-voltage pulse transformer whenever the thyratron is fired. The high-voltage pulse from the pulse transformer is applied to the trigger electrode of the flash-tube. The R-C time constant of the charging resistor and energy storage capacitor was chosen to fire the 2D21 reliably to a maximum rate of 60 times a second.

A three-stage amplifier with clipper circuits meets the requirements of the flashtube trigger and satisfies the desired accuracy of position-indication. The phase shift through the amplifier is constant, within a few degrees, over 10 to 100 cps, the range of input frequencies used.

The amplifier output voltages and, therefore, the eccentricity magnitude reading are independent of variations in the barrier rotational speed over a reasonably wide range such as 10 to 100 rps.

A plot of pickup coil voltage measurements versus the barrier rotational speed indicated that the coil voltage increased 6 db for each octave increase in rotational speed. The amplifier-clipper circuit was designed so that output voltage decreases 6 db per octave from 5 to 120 cps. Thus the amplifier output voltage reading for a barrier of given offset remains constant regardless of variations in the air-motor speed.

The amplifier provides output voltage as a linear function of input signal voltage from 0 to 70 millivolts rms. This results in straight-line calibration graphs that are easy to read and interpret.

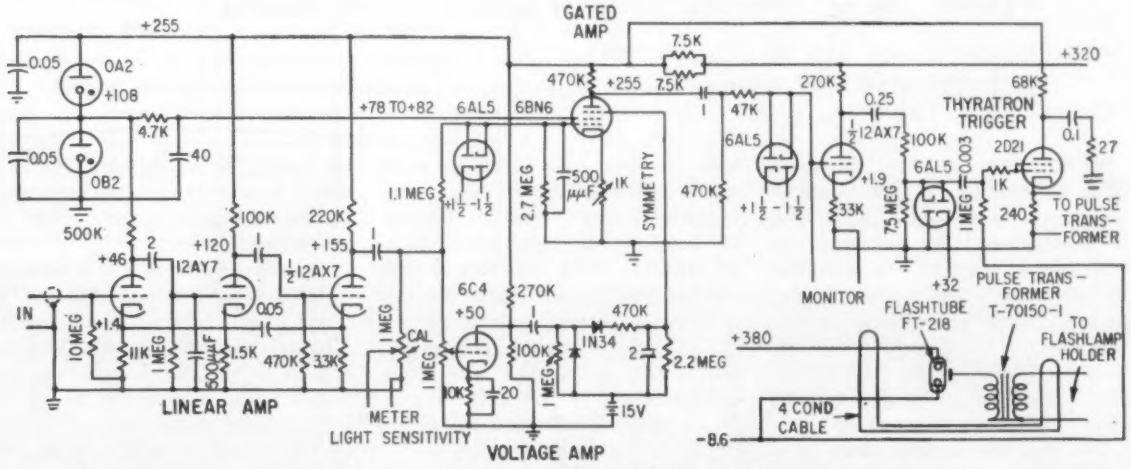


FIG. 2—Flashtube trigger circuit uses a thyratron switch to discharge a capacitor across high-voltage pulse transformer primary

To reduce noise pickup or generation in the input stage, a low-noise dual triode, 12AY7, is used for the first two stages with a special shock resistant tube socket. Also a tube shield with an NEL-type insert reduces the tube operating temperature. The shield is grounded to the chassis. The input stage uses deposited-carbon resistors and is well shielded. Desired frequency response is obtained by a negative feedback system wherein the voltage developed across the cathode resistor of the third amplifier stage is coupled back to the cathode of the first amplifier. As the feedback capacitor is located in a low-voltage low-impedance path, its voltage rating can be relatively low and the stray capacitance is eliminated.

Spurious firing due to bumping or jarring the gage is eliminated by incorporating a 6BN6 gated-beam tube controlled by an integrating network with a long time constant. A portion of the output voltage from the linear amplifier is amplified in the 6C4 voltage amplifier, rectified and turns on the gated-amplifier after a suitable signal persists for several seconds.

The feedback amplifier output voltage goes directly to the vacuum-tube voltmeter where the rms voltage reading is used—in conjunction with a set of graphs—to indicate magnitude of barrier eccentricity, see Fig. 3. This same output voltage is clipped and fed into the 6BN6 gated-amplifier. Clipping prevents overdriving the 6BN6, and assists in the squaring process that follows. Output of the 6BN6 is clipped by a 6AL5 and fed into a high-mu triode whose output is a square wave of fast rise time relative to the period of the wave. The rise time is approximately 40 μ sec.

The negative portion of the square wave is clipped off and the positive excursion limited to about 30 v by another 6AL5. The resulting waveform is then differentiated and triggers the 2D21 thyratron.

The small box mounted on top of the steel box to the left of the gage frame in the photo contains a switch and a three-position attenuator. The switch is normally connected to the connector marked MONITOR on the main chassis and turns off the flashtube portion of the circuit by grounding the grid of the high-mu triode amplifier. This increases flashtube life by minimizing unnecessary firing. The three-position attenuator reduces the wide range of coil voltages (5 to 700 millivolts) to the range that falls within the input capabilities of the linear amplifier. Thus accuracy of the instrument is enhanced by spreading the total range of barrier offset readings (0.001 to 0.125 in.) over three graphs instead of one, as shown in Fig. 3.

Bias control in the cathode circuit of the 6BN6, marked SYMMETRY, adusts the symmetry of the two halves of the square wave output from the 6BN6. Proper setting of the SYMMETRY control determines the accuracy of the indication of position of maximum eccentricity. To set this control, a signal of approximately 40 to 50 millivolts rms is fed into the feedback amplifier input from a signal generator. A cro connected to MONITOR displays the square-wave output. Also, the symmetry control is set to the position that makes each half of the square wave cover an equal time interval.

The shaped charge and gage were developed in a research effort conducted for Jet Research Center, Inc., Arlington, Texas.

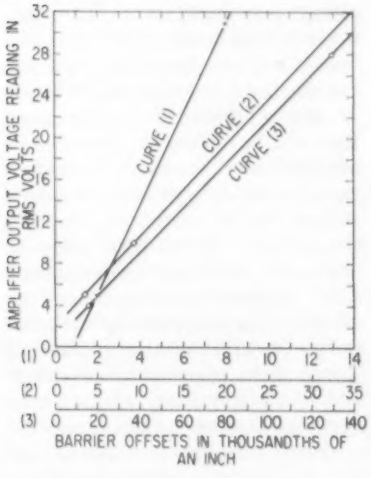
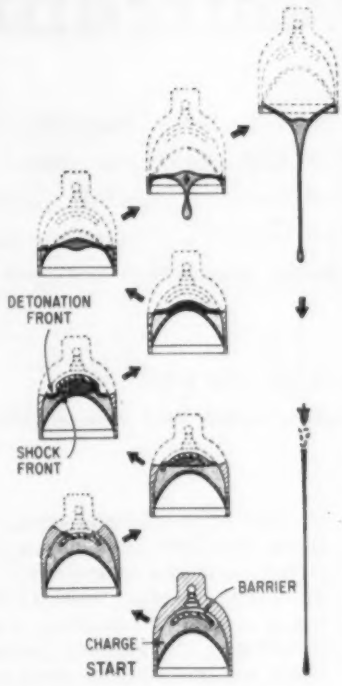


FIG. 3—Offset of encapsulated metal barrier is plotted against amplifier output. Offset readings, plotted on three lines, enhance instrument accuracy



EXPLOSION OF A BARRIER CHARGE

Diagram shows what happens when a high-explosive barrier charge is detonated and illustrates the key role played by the curved steel barrier in shaping the direction and magnitude of the high-velocity jet of metal which perforates the metal casing, cement and formation, permitting the oil to enter the well.

This charge contains 19 grams of high explosive (Cyclonite) in a case made of Zamek 5 (94 percent zinc) with a barrier of mild steel centered as accurately as possible.

In manufacturing the shaped charge, a portion of the high explosive is first pressed into place with the open end of the case facing upward. The concave steel barrier is centered in the charge and the remaining portion of the high explosive is pressed into place and capped by a copper liner. Thus it becomes impossible to visually check whether the barrier has remained centered.

It is possible to locate placement of the encapsulated metal with an overall accuracy of approximately 0.001 in. in magnitude of eccentricity and plus or minus fifteen degrees in position of maximum eccentricity.

Line Current Controls

Low-power oscillator provides both unmodulated and 60-cps modulated signals for carrier-current transmission to control receiver in tv set. Unmodulated carrier of required duration controls channel selection while modulated carrier controls sound level. System operates on one of four nonadjacent frequencies to avoid interaction between nearby systems

By J. R. BANKER and C. H. WOOD, Jr.*

Television-Radio Division, Westinghouse Electric Corp., Metuchen, N. J.

USE OF CARRIER CURRENT enables remote control of channel selection and sound level in tv receivers. The control system to be described comprises a small hand-held low-powered transmitter and a companion receiving unit mounted adjacent to the tuner in the set.

Transmitter

The complete remote-control transmitter is shown in Fig. 1. A straightforward Hartley oscillator circuit is used.

An unmodulated carrier of the required duration is used for channel selection while 60-cps modulation of that carrier is used for sound control. Modulation is readily accomplished by switching the oscillator plate circuit from the dc side of the rectifier to the a-c. The self-indicating control switch provides nonambiguous operation; movement of the switch from center is momentary in the direction for channel selection, while a latching position for the sound function is provided when moving the lever in the other direction.

Interference between neighboring transmitters and receivers is eliminated through the use of four individual frequencies—52.5, 57.5, 67.5 and 73.5 kc. Either of two nonadjacent carrier frequencies may be selected by an easily accessible switch. The remaining two frequencies require repositioning of the coil core.

By making the switchable carrier frequencies nonadjacent, there is no possibility of interaction between two units. Coupling to the power line is by a nonresonant low-impedance secondary, with C_1 acting as a blocking capacitor. Autotransformer T_1 supplies filament power and the selenium rectifier in a half-wave circuit supplies d-c, filtered by C_2 for the unmodulated signal.

Requirements of the FCC regarding radiation above 450 kc have been fulfilled by controlling the harmonic output of the transmitter by four methods. Power output has been limited to 12 mw in the unmodulated case, a low-pass filter comprising R_1 and C_2 is used. Resistor R_1 also limits the power output and by carefully choosing the feedback ratio by the position of the tap on the coil power is also limited.

Receiver

The receiver shown in Fig. 2 can be considered as two separate receivers, one capable of detecting an unmodulated carrier while remaining insensitive to a modulated one, the other detecting both modulated and unmodulated carriers.

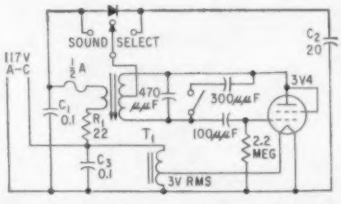


FIG. 1—Complete remote-control carrier-current transmitter

The section sensitive only to an unmodulated carrier energizes a relay for channel selection, while the section sensitive to both signals energizes the sound muting relay. By making the sound muting section sensitive to both signals, the audio level is automatically lowered simultaneously with channel selection, thus avoiding bursts of sound.

Several characteristics of the receiver are functions of its source impedance. Though the impedance of the power line at a given frequency may be represented by a single resistance and reactance, this value is difficult to determine. Furthermore, the value continually changes as equipment and appliances are switched on or off.

For a given line under average conditions, it is convenient to speak of the equivalent line impedance, that single resistance value which when shunted across the output of the transmitter reduces the output voltage to the same value as does the a-c line. Values from 10 to 50 ohms have been measured, although it is possible that it may be as high as 200 ohms. Since this variation causes a corresponding change of the Q of the receiver tuned circuit which in turn results in wide variations in receiver selectivity, it is essential that the receiver always see the lowest source impedance. The tv receiver with which this system is used employs a 0.15-μf

* Now with Electronics Div., Baltimore, Md.

Remote Tv Receiver

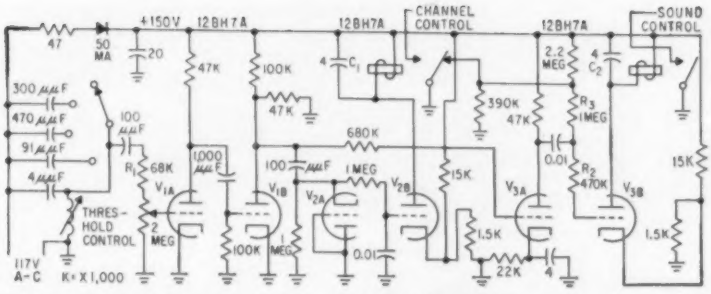


FIG. 2—One part of receiver detects only unmodulated carrier while other part detects both modulated and unmodulated signals

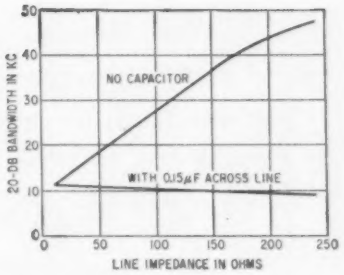


FIG. 3—Receiver selectivity as a function of line impedance

line bypass capacitor to reduce sweep harmonic radiation. This holds the line impedance at the a-c terminals of the receiver fairly constant at 10 ohms regardless of actual impedance variations.

Circuit Features

The input of the remote-control receiver has a single series-tuned circuit connected across the a-c line. The impedance of this circuit appears as 41 ohms. This is a deliberate mismatch to the 10-ohm line to secure the desired selectivity. The effect of controlled line impedance on the selectivity of the receiver is shown in Fig. 3.

Four individually-tuned frequencies are selectable by switching additional capacitors across that for the highest frequency. To achieve the desired accuracy, two-percent mica tuning capacitors are used.

A threshold control at the input of the first r-f amplifier allows the receiver sensitivity to be adjusted to meet individual requirements. Due to Miller effect, the input of the first stage is not extremely high in impedance and has considerable capacitance. Resistor R_1 (Fig. 2) prevents a change of Q and detuning of the resonant circuit with variation in the threshold control. The second function of this resistor is to clip noise pulses appearing with the signal.

For the channel-switching function, V_1 is a two-stage carrier-frequency amplifier, the second stage also acting as a limiter. The unmodulated carrier in passing through peak rectifier V_{2A} produces a positive d-c voltage. Channel-relay stage V_{2B} is biased near cutoff. The output of V_{2A} is directly coupled to the grid of V_{2B}, increasing the plate current to operate the relay. The modulated carrier used for sound control is similarly rectified by V_{2A} and increases the plate current of V_{2B}.

Because the modulated carrier has a duty cycle of only 35 percent and the maximum signal from the plate of V_{1B} is limited, it is never sufficient to operate the channel relay. Thus there is no undesirable cross-function operation. Capacitor C_1 across the channel relay coil removes the 60-cps component which would otherwise appear and cause buzzing of the relay for sound muting operation.

Muting

For muting control, V_{1B} acts as a grid-leak detector rectifying the modulated carrier and providing amplification at 60 cps. This signal is direct-coupled through a low-pass filter to the grid of V_{3A} which provides additional 60-cps amplification to effect the large grid swing required by sound-relay stage V_{3B}. This stage is biased near cutoff, as is channel-relay stage V_{2B}. Its plate current increases on the average by the large 60-cps signal on its grid. Resistor R_2 reduces the tendency to clamp and thus bias the grid negatively. Capacitor C_2 across the relay removes the 60-cps component.

With no input signal the back contact of the channel relay is closed, grounding the grid return R_3 of sound-relay stage V_{3B}. Whenever the channel relay operates, a positive d-c voltage is applied to the grid of V_{3B} to close the sound relay.

Noise Considerations

It is imperative that the receiver be insensitive to noise, since both regular and random noises exist on the line at all times. Regular noise, resulting principally from fluorescent lighting, may measure 10 millivolts p-p. Random noise may be of the order of 500 millivolts p-p. Since the receiver sensitivity is approximately 30 millivolts, some means of discriminating against noise is necessary to prevent the relays from responding and causing dropouts in the sound or undesired switching of channels.

Excellent noise immunity results from clipping noise pulses at the input of the first stage and using short time constants between subsequent stages. The limiting action of the second stage also contributes to noise immunity. The resulting signal-to-noise ratio is approximately 30 db.

The use of carrier current has solved several problems. The availability of a-c voltage makes it possible to incorporate a power supply in the transmitter. The receiver unit is also self-powered. The tuner in the tv receiver is programmed mechanically to stop only at the channels actually transmitting.

Electronic Control Times

Increased reliability and reduction of down time in production result when thyratrons are used in place of relays for controlling high-speed resistance welding. Typical electronic control described in this article provides fail-safe operation, reduces transients by correct adjustment of the ignitron firing angle, and affords accurate repetition and calibration of the timing cycle

By **STUART C. ROCKAFELLOW,** Robotron Corporation, Detroit, Michigan

HIGH-SPEED resistance welding requires four exact timing functions. The period necessary to bring the electrodes together and build up pressure is called squeeze time. This begins when a solenoid is energized to allow air to enter a cylinder and force the electrodes together. When sufficient pressure is built up, weld time begins, and current flows through the weld transformer. In cases of warping metal or poor jigging, hold time is used to keep the electrodes together while the molten metal is congealing. The electrodes then open, and in fast-repeat operation, the period required to move them to a new location is called off time.

If a relay is used for controlling the weld current flow, there will be an inrush of about 30 amp and the relay will tend to bounce several times before establishing a firm contact, each bounce causing severe transient strain across the solenoid valve coil. The combination of opening and closing the valve in high-speed operations may account for several million transients each day.

The present trend is to use electron tubes for control functions in resistance welders. Maintenance on

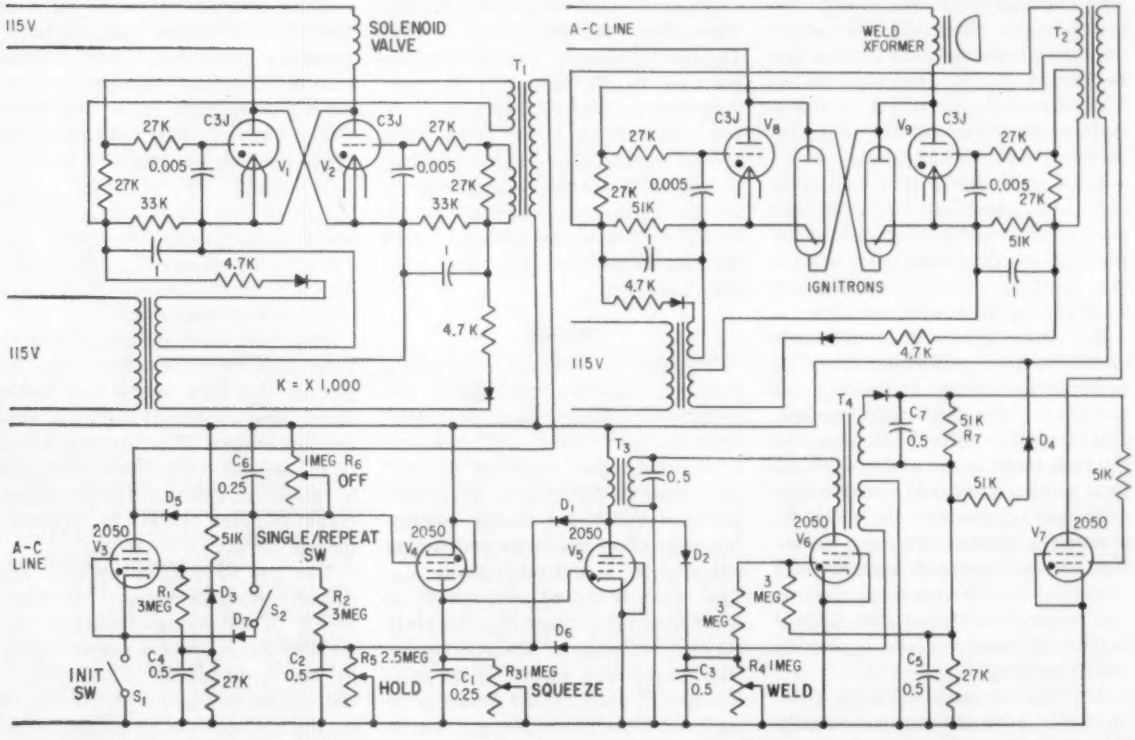
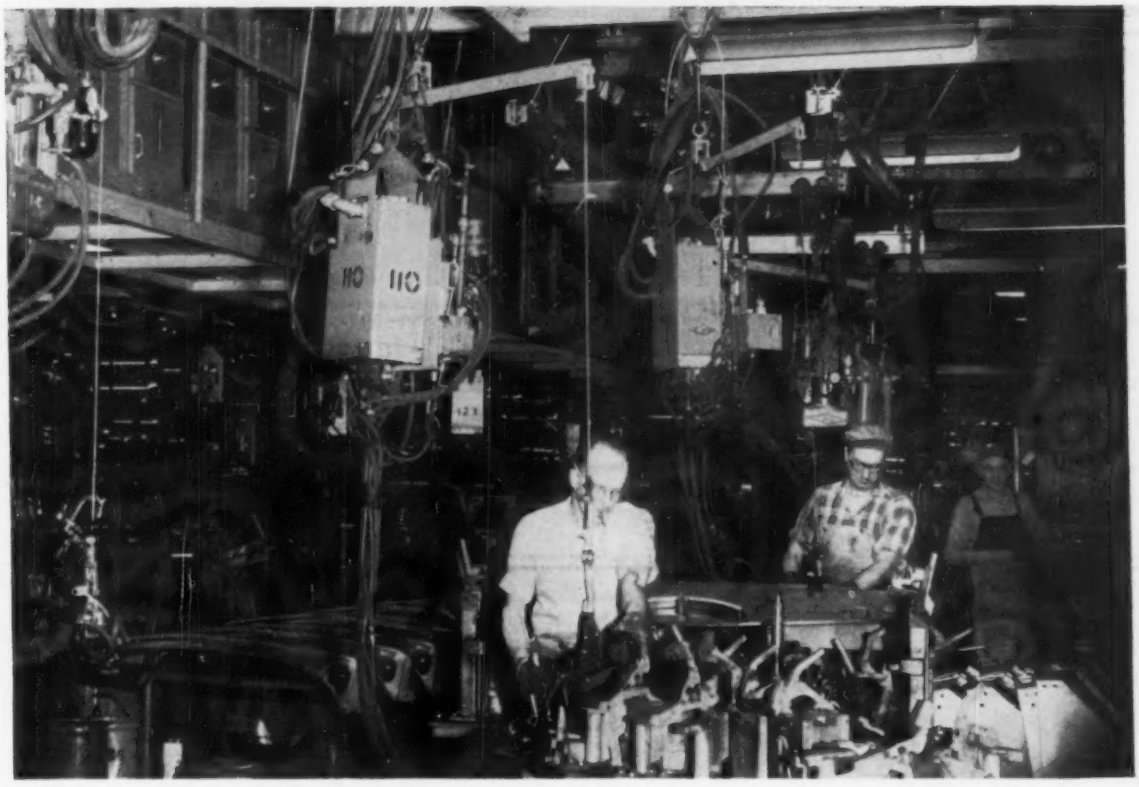


FIG. 1—Schematic of a typical control for a high-speed resistance welding gun. Fuses and overload protection circuits are not shown. This circuit affords either single-shot operation or continuous recycling of the timing functions

High-Speed Welding Cycle



Protracted delays caused by maintenance problems in any of the high-speed resistance welding stations in a production line, such as in this automotive plant, can be costly. All-electronic controls have reduced down time by as much as 90 percent because of their innate reliability. In this installation, all the control units are mounted on a catwalk overhead for ease of maintenance

controls has thereby been reduced as much as 90 percent. This is significant on high-speed production lines, as down time is one of the highest operational costs.

Requirements

The requirements of a high-speed resistance welding control are: fail-safe operation of the timing circuit, fully electronic operation of both solenoid valve and weld-current control, transient reduction by 90-deg firing of the first half-cycle of welding current, highly accurate repetition and calibration, and high-speed operation of over 600 spots/min.

Fail-safe operation is accomplished by using positive voltage on the grid of the timing thyratron. Without this feature, the control might freeze the gun to the work on a high-speed production line and cause downtime.

Weld Current

To keep transients to a minimum, the weld current should be initiated at about 90 deg on the voltage wave for the first half-cycle only, and current flow should be terminated at the completion of a half-cycle opposite in polarity to the starting wave. When electron tubes are used to accomplish this critical timing, the firing angle and termination point will remain consistent after millions of operations. Furthermore, the fuses or other overload protection devices may be selected without having to compensate for high transients.

An example of a typical fully-electronic control of high-speed resistance welding guns is shown in Fig. 1. Relays may be used as safety cutoff devices, but all operations are dependent on electronic timing.

The solenoid valve is actuated by a pair of 3-amp thyratrons V_1 and V_2 which will handle 40-amp inrush current. The tubes in this portion of the circuit eliminate the electrical strain imposed on the valve coil when relays are used. The same type 3-amp thyratrons V_3 and V_4 are used to control the weld current through the ignitrons and give accurate control for the 90-deg firing. Five smaller type-2050 tubes are used for the electronic sequencing and timing control.

All assemblies are held in place with quick-change fasteners and are electrically interconnected by plug-in connectors. Ignitrons are available using manual pressure

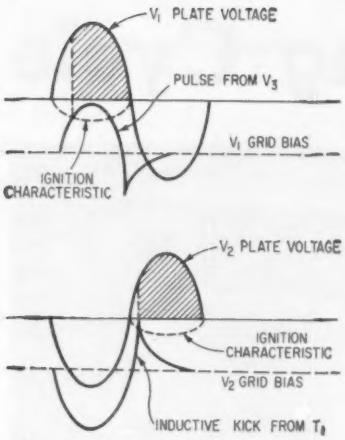
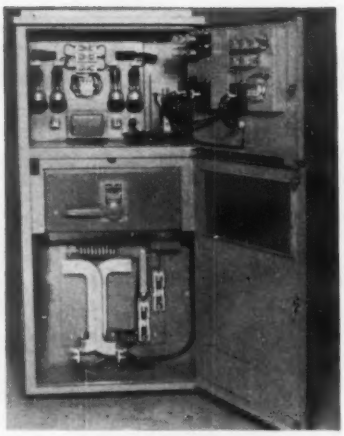


FIG. 2—Waveforms depict how full-wave control of solenoid valve is maintained by single positive pulse from V_3. Shaded area indicates ignition period



Interior view of resistance welding control unit. The relays at top are safety cutout devices; all other functions are electronically controlled

connections instead of bolts, and the water connections are changed with pressure-lock connectors.

Operation

With the timer at rest, but with power applied, capacitor C_1 is charged by conduction of V_4, C_2 is charged through rectifier D_1, C_3 is charged through D_2, C_4 is charged through D_3, and C_5 is charged through D_4.

Valve-firing tubes V_1 and V_2 are each held nonconducting with about 60-v bias on their grids, while the weld-control tubes V_4 and V_5 are held blocked in the same manner. One pulse can be used to fire both V_1 and V_2 by using the inductive kick from T_1. Thus the positive pulses from V_3 will control both the positive and negative half-cycles to give full-wave control of the valve. This is shown graphically in Fig. 2. The same type of control is used to energize the weld transformer for full waves of current. When phase shift is necessary, a trailing tube is added and a phase-shift circuit controls T_2.

There is a negative bias of about 30 v on the grid of V_3 developed through R_1. At rest, the top of capacitor C_2 is about 100-v positive. This voltage is applied to the grid through R_2. When initiating switch S_1 is closed, V_3 conducts, energizing the solenoid valve by causing conduction in V_1 and V_2. With T_1 energized, the voltage drop across its primary is rectified by D_5 to charge C_6.

The charge on C_6 puts a negative voltage on the grid of V_4 sufficient to block this tube. Capacitor C_7 then discharges through R_3 for the squeeze time. When the voltage across C_5 drops to about 1 v, tube V_5 fires and energizes T_2. This also effectively shorts the positive pulses across the line, and rectifiers D_1 and D_2 stop charging their capacitors. The plate supply for V_6 is derived from the secondary of T_2. This tube now conducts because the high positive voltage from C_3 overcomes the negative bias from C_5. With T_4 energized, pulses are fed back through D_6 to keep C_2 charged. Positive pulses are also fed to the grid of V_7 to overcome the negative bias, and the resulting conduction energizes the weld tubes.

Weld time starts when V_5 conducts, halting the charging of C_3 through rectifier D_3. When C_3 discharges through R_4 to a potential of about 29 v, the negative bias from C_5 blocks V_6, thus ending the weld time by removing the positive pulses from the grid of V_7. With its charging source removed, C_2 drains through R_5 for the hold time. When the positive charge of C_2 drops to about 29 v, the negative voltage on C_4 blocks V_3 to end the hold time.

With S_2 in the REPEAT position, blocking of V_3 deenergizes T_1 and removes the source of charging current for C_6. This capacitor discharges through R_6 for the off time. With the bias drained down, V_4 conducts and charges C_1. The negative voltage at the top of C_1 blocks V_5 and this immediately allows positive-pulse conduction through D_2 to recharge WELD capacitor C_3, and HOLD capacitor C_2 through D_1. With the initiating switch held closed, charging of C_2 puts a positive voltage on the grid of V_6, causing it to fire and start another sequence.

For single-shot operation S_2 is placed in the SINGLE position. Closing S_1 charges C_6 through D_7 stopping the operation at the end of hold time as long as S_1 is closed.

Capacitor C_7 accomplishes the 90-deg firing. At the start of the first weld pulse C_7 is completely discharged and takes 90 deg of the sine-wave pulse to charge fully. For this period no energy is fed to the grid of V_7. After the capacitor is charged, however, the remainder of the half-wave pulse gets through to V_7, overcoming the bias and causing the tube to fire at the 90-deg angle.

Now C_7 is charged fully on the first pulse and offers no shorting effect for the duration of the weld time. At the end of weld time C_7 is discharged through R_7 to be effective for the first pulse of the next weld-time period.

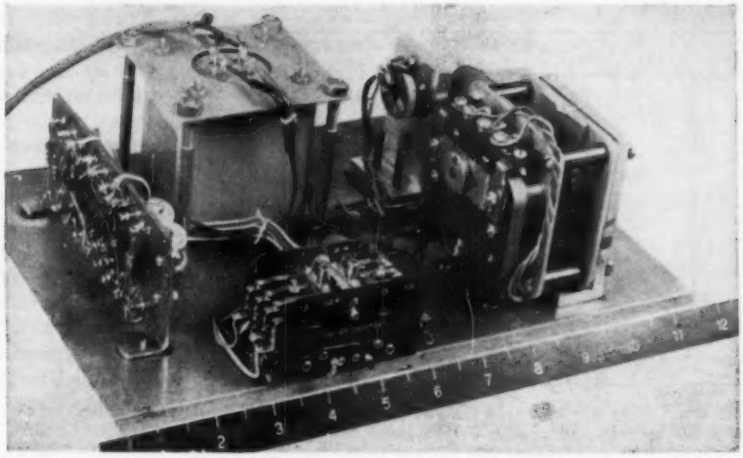
Construction

To conserve space, grain-oriented core transformers are used. These small transformers perform as well as the stacked-iron type, but they must be energized and deenergized at the correct points on the voltage wave to prevent saturation.

By using special plug-in phase shift units incorporating a trailing tube, either heat control, slope control, or current regulation can be used with the timer to accurately control current at the weld zone.

Calibration accuracy is essential for high-speed controls because of the possible necessity of fast interchange of panels during production. If the calibration accuracy of all controls is the same, replacement panels will give consistent operation without further adjustment. Because weld time is the most important function controlled by the unit, tap switches are generally used instead of potentiometers.

Both the valve solenoid and weld transformer must be in phase with the timer supply to be effective.



Transistorized relay servo has transistor amplifier (left), step-function potentiometer (right rear), reversible motor (right) and differential relay (front)

Transistors Reduce Relay Servo Size

Relay servo system simulates on-off control device by using step-function potentiometer to provide on-off characteristic of the null detector. Easily adjusted damping is applied through differential relay contacts to eliminate oscillations; fast response to small angle displacements assures close following

By **SAUL SHENFELD,** U. S. Underwater Sound Laboratory, Fort Trumbull, New London, Connecticut

DESIRE FOR COMPACT and efficient servo devices has grown with the postwar expansion of servo applications. Originally great efforts were expended on the design of linear components, but currently servo systems using less expensive nonlinear components are in demand.

This article describes a transistorized relay servo system which illustrates the simplicity possible in design of the nonlinear type.

Positional Units

Nonlinearities existing in the servo system shown in Fig. 1A are approximated by linear transfer characteristics. When the servo device is used as a positional system, the block $KG\ (j\omega)$ represents an electronic amplifier, a motor and a gear train. Except for errors resulting from nonlinearities such as static friction and backlash, the positional error is zero. A high-gain amplifier provides desirable performance, and compensating networks prevent oscillation.

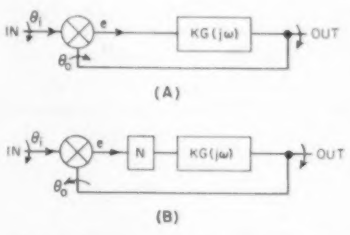


FIG. 1—Linear (A) and relay (B) servo systems can both be used as positional units in antenna systems and the like

The relay-type system shown in Fig. 1B has a full on or off voltage applied to the servo motor. In this system, a high degree of nonlinearity exists between the input error and the drive force applied to the servo motor.

Relay-type servo systems have

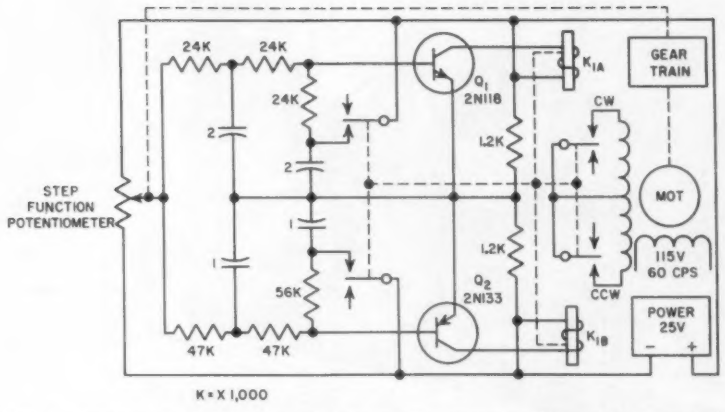


FIG. 2—Tapping positive voltage off step-function potentiometer causes current flow in Q_1 transistor, operation of relay K_{1A} and upward movement of arms. Negative voltage moves arms downward reversing direction of motor travel

the error signal available in both magnitude and sign, or in sign only. Block *N* of Fig. 1B, the nonlinearity in the system, may be in one or more places including the error-detector system.

Stabilization

Oscillation cycles whose amplitude and frequency depend on the parameters of the system exist in the relay servo. Damping devices that increase the natural frequency of oscillation to the point where the amplitude of the cycle is negligibly small stabilize the relay servos.[1] These devices anticipate the point of correspondence between the input and the output shaft and apply a breaking torque to the motor prior to this point. By introducing a small dead zone into the system, continuous hunting is eliminated.

Reduction in size and weight of relay servo systems is achieved with efficient and compact relays which control power output in watts with microwatts of input. Use of nonlinear servo systems is mandatory where the available null detector is nonlinear outside of a narrow region at the null position. Since the system is insensitive to variations in gain, the gain parameter may vary over wide limits without affecting response characteristics.

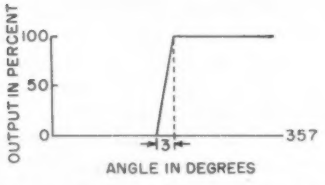


FIG. 3—Characteristic of step-function potentiometer has 3-deg segment during which there is linear variation from zero to full output current

Description of Equipment

The transistorized relay servo system shown in Fig. 2 has a step-function potentiometer with the characteristics shown in Fig. 3. The potentiometer simulates the on-off characteristic of the null detector. The dead center or null position of the servo system corresponds to the center of the linear range of the potentiometer.

The potentiometer has 360 deg of mechanical rotation and 357 deg of electrical contact. During a 3-deg segment of the potentiometer rotation, a linear variation from zero to full output is obtained. The R-C time lag from the potentiometer to the base of the transistors simulates the time constant of the actual mechanical and motor system. Time constant variation produces undamped oscillations at the frequency of the actual system.

To equalize the sensitivity of the *npn* and *pnp* transistors, the series base resistors of the *npn* transistor are halved and the value of the capacitor associated with the smaller resistor doubled to compensate for the unequal time constant.

Compatible Performance

Transistors and relays are extremely compatible for on-off servo applications. Current drain for operation of the system shown in Fig. 2 is about 14 ma at 25 v. Since 10 ma is required as bleeder current for a center-tapped supply, actually only 4 ma at 25 v is required by the relay servo system.

The transistors are connected across a split 25-v power supply. Connection of the arm of the potentiometer to the positive side of the supply causes 4 ma, sufficient to operate the relay, to flow in transistor Q_1. Except for reverse collector current, there is no current in Q_2.

With the potentiometer arm connected to the negative supply, 4 ma flows through the other coil of the

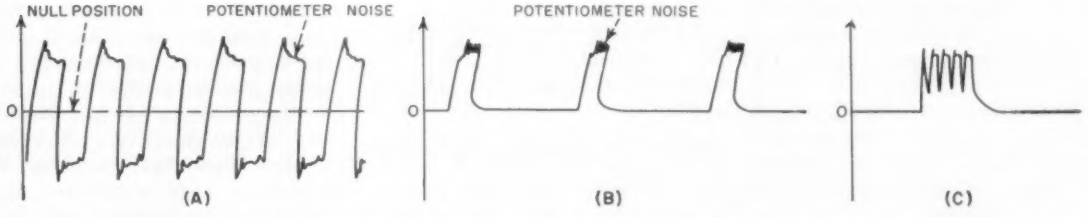


FIG. 4—Slider voltage of step-function potentiometer has undamped oscillations (A) and response to three step displacements of output shaft (B). Damping voltage (C) applied to base of off transistor has exponential character

differential relay and actuates the relay in the opposite direction. Since relay-system contacts are connected to the control winding of a reversible, shaded-pole motor, closing either set of contacts drives the motor toward the central position of the potentiometer. When there is no current in either coil, the relay is in its neutral position and the motor is not excited.

Damping

For a step displacement of the motor shaft, the slider voltage of the step-function potentiometer is shown in Fig. 4A where damping is not used. The voltage waveform illustrates the oscillatory nature of the output shaft position. The amplitude of the displacement corresponds to several deg on each side of the null position.

When base current is supplied to the off transistor as the relay closes, 2 ma of collector current, sufficient to return the relay to its neutral position, is produced in that transistor. By adjusting the value of the capacitance in the base circuit the amount of damping is changed for the desired response. The slider voltage obtained for three step displacements of the output shaft is shown in Fig. 4B. Potentiometer noise produces the variation of the correction voltage appearing at the top of the waveform.

The damping voltage shown in Fig. 4C and applied to the base of the off transistor decelerates the motor by tripping the relay off. This feedback voltage decays exponentially. Feedback prevents the motor from running at top speed and overshooting after it reaches the null position.

Position and Velocity

A sketch of the position and velocity of the output shaft superimposed on the phase-plane plot is shown for the damped and undamped cases in Fig. 5. The curve for the undamped case corresponds to one set of initial conditions. A family of such curves is obtained for various initial shaft displacements or initial shaft velocities. In the undamped case the phase-plane plot consists of parabolic segments when the motor's self-damping is small.[2] When damping forces on the motor are neglected, the equation of motor torque and acceleration is

$$T = I\,(d^2\theta_o/dt^2) \qquad (1)$$

where T is motor torque for full excitation, I is rotational inertia and $d^2\theta_o/dt^2$ is acceleration. Then

$$\omega_o(t) = (T/I)\,t + C_1 \qquad (2)$$

where ω_o is output shaft angular velocity and constant C_1 is shaft angular velocity at $t = 0$. Furthermore,

$$\theta_o(t) = (T/2I)\,t^2 + C_1 t + C_2 \qquad (3$$

where constant C_2 is the angular shaft position at $t = 0$.

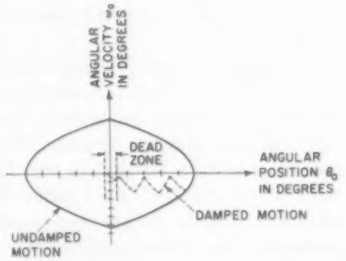


FIG. 5—Position and velocity of output shaft is superimposed on phase-plane sketch for damped and undamped cases

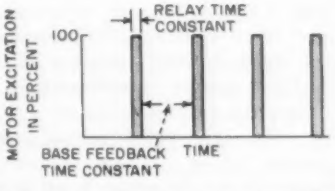


FIG. 6—Graph shows motor excitation time as function of relay time constant, and braking time as a function of feedback time constant

Equations 2 and 3 are the parametric equations of the shaft motion in terms of time. When plotted on the phase plane for initial shaft displacements or velocities, the parabolic curves of Fig. 5 are obtained. With on-off control the point of motor reversal is

$$-\omega_o^2 + (2T/I)\,\theta_o = 0 \qquad (4)$$

or

$$\omega_o^2 + (2T/I)\,\theta_o = 0. \qquad (5)$$

The quadrant of operation determines the appropriate equation to be used.

Equations 4 and 5 indicate the points on the reference plane for reversing the motor torque and bringing the output shaft to the null position in minimum time. This defines an optimum system in terms of minimum response time and zero overshoot. Equation 1 is only applicable for time intervals which are short with respect to the time constant of the servo drive motor.

System Advantages

Base-current damping does not give optimum system speed response but has the valuable features of simplicity and ease of adjustment. The degree of damping is adjusted by varying the time constant of the base feedback voltage. Essentially, impulse excitation of the motor control winding restores the shaft to the null position with the spacing of the impulses determined by the feedback time constant. Figure 6 shows the excitation time as controlled by the relay time constant, and the braking time by the feedback time constant.

With this system, the shaft is returned to the null position with a low energy storage assuring small amplitude of the stable oscillation. By introducing a dead zone and a center-position relay into the system, the oscillation is reduced to zero. Where a velocity input must be followed, base-current damping is desired, since the speed of response is fast for small displacement angles.

The system also has high damping. For small angles, operation approaches that indicated by Eq. 4 and 5. The maximum average velocity followed by the system is reduced by the impulse excitation, but within the velocity follow-up limits, satisfactory performance is obtained.

References

(1) A. Tustin, "Automatic and Manual Control," Academic Press, New York, 1952.

(2) D. MacDonald, Nonlinear Techniques for Improving Servo Performance, *Proc NEC*, **6**, p. 400, 1950.

Logical Design of SAGE

Speed and clarity of information are prime requisites of any effective radar system such as SAGE. The monitor described accomplishes these objectives and eliminates other unnecessary data simultaneously. Logical design of the equipment and detailed circuitry show how its done

By **BYRON L. BAIR***, Bendix Radio, Division of Bendix Aviation Corporation, Baltimore, Maryland

VISUAL DISPLAY of selected long-range radar inputs to the SAGE computer is provided by equipment known as the long-range radar input monitor control. The equipment consists of one large unit containing digital and analog portions and four display consoles. The types of display presented are shown and described in Fig. 1.

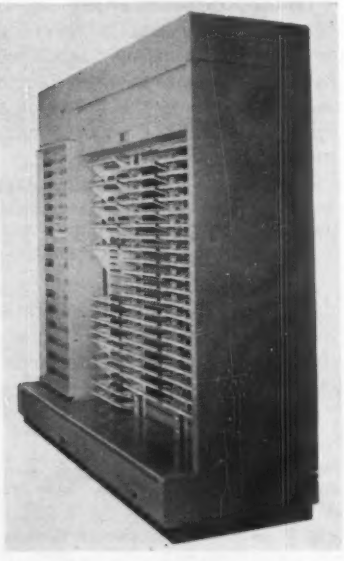
The monitor operator can select any one of 15 radar sites and any one of 14 types of messages. The messages identify the type of target; that is, ships, land masses, enemy aircraft and commercial aircraft. Desired selections are passed over to the digital portion of the equipment for comparison with incoming data. If the incoming site identity and message-label codes match a desired selection, a display of range R and azimuth data θ is made.

Input to the monitor consists of two successive digital words fed in parallel form and separated from each other in time by 10 μsec. First word contains a radar site identification and message-label code; the second contains target range and azimuth data. Other information is contained in the words also but is not used by the monitor.

Logic for the word discriminator is shown in Fig. 2. Simultaneous reference to the timing chart in Fig. 3 is helpful.

A drum demand (DD) pulse from the drum control circuitry in the SAGE computer is received 6.5 μsec before the first word (point A, Fig. 3). No DD pulse precedes the second word, thereby allowing determination of which word of the message has been received. At the same time the DD pulse is received, an OD-3 clock pulse arrives. The OD-3 pulse is delayed 1.5 μsec (point B, Fig. 3). After the 1.5-μsec delay of OD-3, it strobes the first gate in the output line of the flip-flop. The second gate is not affected because its suppressor grid is at −30 v. The resultant pulse sets a type-C flip-flop and goes through the register reset unit to reset all the storage registers.

After five more μsec, the first word arrives (point C, Fig. 3) and is stored in the registers. Simultaneously, a data available (DA)



Front view of the long-range-radar input monitor

FIG. 1—Display of selected long-range-radar inputs to SAGE computer. Display is presented on a 16-in. crt mounted in console. Dots simulate targets in display used to check monitor operation. Test display differs from tactical display in that all noise and other spurious returns are filtered out. As in a ppi display, north is up, east to the right, etc. Data panels show equipment name, time of day, exposure time of photograph, radar site and type of message

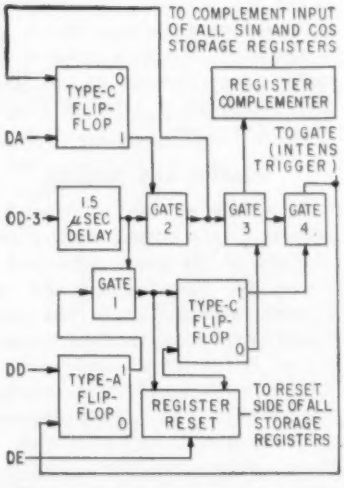


FIG. 2—Logical design of word discriminator

* Now with Link Aviation Inc., Binghamton, N. Y.

Radar Input Monitor

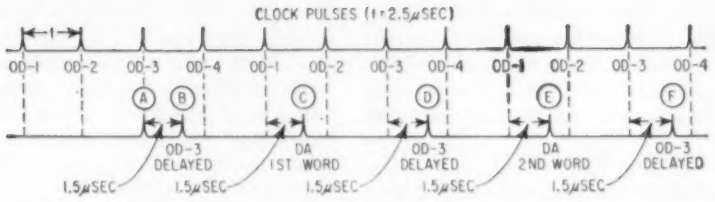


FIG. 3—Timing chart for monitor. Clock pulses are spaced 2.5 μsec apart and cycle is repeated every 10 μsec. Data available (DA) pulse arrives with both first and second words

Table I—Register Complementing for Correct Quadrant Representation

Quadrant	2^{11} Bit	2^{10} Bit	Complement	
			Sin Register	Cos Register
1	0	0	2^{10}	All
2	0	1	2^{10}–2^{0}	All
3	1	0	2^{10}–2^{0}, 2^{11}	None
4	1	1	2^{10}, 2^{11}	None

pulse arrives and sets a type-C flip-flop. In the next five μsec, information stored in the site and message-label registers is compared with the word requested at the consoles to decide whether or not to display the second word.

The next time an OD-3 pulse is received and delayed (point *D*, Fig. 3), gates 1 and 2 are strobed. Output from gate 1 resets the storage registers through the register reset unit. Output from gate 2 resets the DA flip-flop and strobes gate 4. The output pulse from gate 4 resets the two flip-flops and strobes the selector output gate to start the display timer if a selection has been made. There is no output pulse from gate 3 since its suppressor grid is at −30 v.

The DA pulse associated with the second word and the second word arrive five μsec after the second OD-3 delayed pulse (point *E*, Fig. 3). The second word is stored in the registers while the DA pulse sets a type-C flip-flop. At this time, the condition of the flip-flops storing the two most significant bits of the azimuth information is sampled to determine which quadrant the message represents. The register complementer then has outputs available to complement the storage registers. This action is necessary to insure that the output levels will represent the required quadrant correctly.

The next OD-3 delayed pulse (point *F*, Fig. 3) strobes gates 1 and 2. There is no output from gate 1 since its suppressor is at −30 v. Pulse output from gate 2 resets the DA flip-flop and strobes gates 3 and 4. There is no output from gate 4 since its suppressor is at −30 v. Output from gate 3 strobes four gates in the register complementer allowing the necessary complementing to be accomplished.

The next OD-3 pulse has no further effect since the two gates which it strobes have their suppressors at −30 v. The operational sequence is not started again until another DD pulse is received. If the received message is not selected for display, the next DD pulse starts the sequence again.

If the message is selected for display, a display-started (DS) pulse is supplied to the common equipment where further DD pulses are inhibited until the display period ends.

At the end of the display period, a display-ended (DE) pulse is generated which resets the storage registers. The DE pulse is supplied to the common equipment also and deinhibits the DD pulses. Timing and control of the DS and DE pulses are functions of the display timer. It will not be described in detail because of space limitations.

Storage Registers

Three flip-flop storage registers are provided in the digital portion to store the received information bits. These are: a site and message-label storage; range storage; and azimuth storage.

Site and message-label informa-

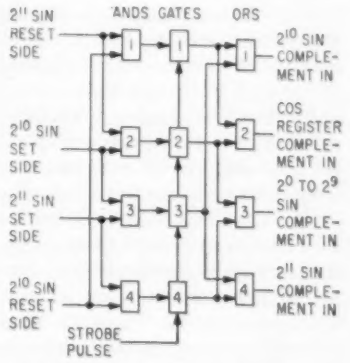


FIG. 4—Logical design of register complementer

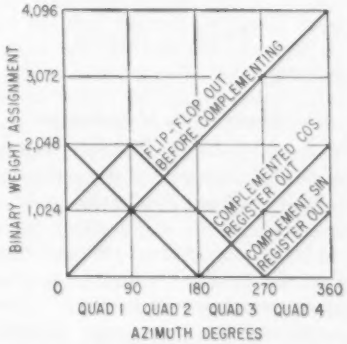


FIG. 5—Effects of register complementing

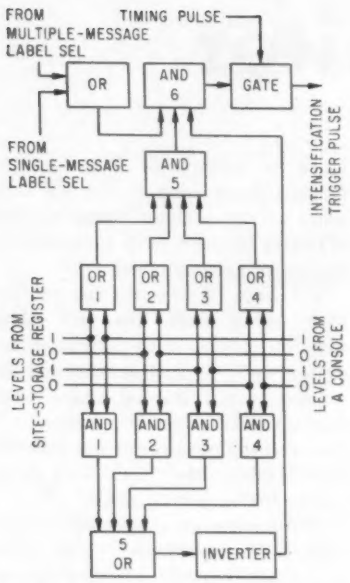


FIG. 6—Logic of the site-selection portion of the monitor

tion are stored in a nine-bit storage register arranged so that input may be changed readily to accommodate any rearrangement of bits making up the first word. Outputs of this register are connected to the display selection circuitry so that a comparison can be made with the site and message-label words requested at the consoles.

Range information is stored in a 10-bit register. When a display is to be made, outputs of this register are fed to the range decoder in the analog portion without alteration.

Azimuth data is fed in parallel to two storage registers. All 12 bits are stored in one of the registers, outputs of which go to the sine decoder in the analog portion. The first 11 bits (2^0 to 2^{11}) are also stored in the second register. Outputs from this second unit are fed to the cos decoder in the analog portion.

Register Complementer

Logic for the register complementer is shown in Fig. 4. The two most significant bits of the sin-storage register are fed to the complementer. Condition of the two register flip-flops indicates the message quadrant. Azimuth data stored in the sin-storage register represent a specific angle. This information is used only once and then discarded. Assume, however, that the azimuth information started at 0 deg and increased successively to 360 deg. Then, the summed output of the azimuth storage register through all four quadrants would appear, without register complementing circuitry, as the flip-flop output before complementing as shown in Fig. 5. The register complementer complements both the sin- and cos-storage registers to produce a triangularly shaped output approximating either the sin or cos of the azimuth angle stored in the registers. Result of this complementing is indicated by the remaining two lines in Fig. 5.

Table I shows that condition of the two most significant bits (2^{10} and 2^{11}) of the sin-storage register is unique for each quadrant. Other columns of the table indicate which bits of the sin and cos registers must be complemented so that output levels correctly represent the quadrant.

In the first quadrant there are zeros on the lines for the 2^{10} and 2^{11} sin set sides and ones on the lines for the reset sides referring to Fig. 4. As a result, only AND circuit 1 has an output. When this level is gated through gate 1, an output pulse is obtained from OR circuits 1 and 2 which complement all of the cos register and the 2^{10} sin flip-flop after passing through the appropriate driver circuitry.

In the second quadrant, zeros appear on the lines from the 2^{11} sine set side and the 2^{10} sin reset side. Ones appear on the other two lines so that only AND circuit 2 has an output. When this output level is gated through gate 2, an output pulse is obtained from OR circuits 2 and 3. These pulses pass through the driver circuitry and complement all of the cos register and the 2^0 through 2^9 sin flip-flops.

In the third quadrant, there are ones on the lines from the 2^{11} sin set side and the 2^{10} sin reset side while the other two lines have zeros on them. In this case, only AND circuit 4 has an output which is gated through gate 4 at the correct time. An output pulse is then obtained from OR circuits 3 and 4. These pulses pass through the driver circuitry and complement all of the sin registers except for the 2^{10} sin bit which remains uncomplemented.

In the fourth quadrant, ones appear on the lines from the 2^{10} and 2^{11} sin set sides while zeros appear on the lines from the reset sides. Consequently, an output is obtained from AND circuit 3 which is gated through gate 3 at the correct time. An output pulse is then obtained from OR circuits 1 and 4. These pulses pass through the driver circuitry and complement the 2^{10} and 2^{11} sin bits.

Display Selection

Either a particular type of message from a specified radar site or all messages from a specified radar set can be displayed. In the first case, words in the storage registers are compared with words requested at the consoles in the site-identity and single-message-label selectors. In the second case, site-identity and multiple-message-label selectors are used. To avoid switching circuitry, single- and multiple-message-label selectors are fed in parallel. Output of each is combined in an OR circuit. To cause a display, an output must be obtained from the site selector and from one of the message-label selectors. Selection circuitry is built in quadruplicate, one set for each console.

Site-Identity Selector

Logic for the site-identity selector is shown in Fig. 6. A typical binary word (1 0 1 0) has been chosen. Any other word could be compared in a similar fashion. The

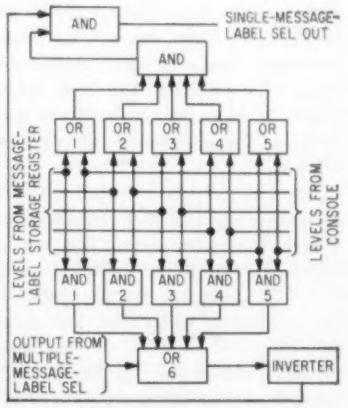


FIG. 7—Single-message-label selection logic

word from the console uses the opposite level notation of the word from the registers. That is, binary one is +10 v and binary zero is −30 v from the registers. But binary one is −30 v and binary zero is +10 v from the console selection switches. Under these conditions and with the particular binary word chosen as an example, OR circuits 1 to 4 have a +10-v output and AND circuits 1 to 4 have a −30-v output. As a result, AND circuit 5 has a +10-v output and OR circuit 5 has a −30-v output. The inverter

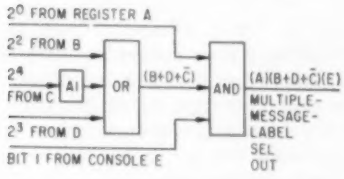


FIG. 8—Multiple-message-label selection logic

changes the −30-v output from OR circuit 5 to + 10 v and feeds it to AND circuit 6. This circuit now has two of the three necessary inputs. If either of the message-label selectors has a +10-v output, the third input requirement will be filled and AND circuit 6 will have a +10-v output. This output is gated out to become the intensification trigger pulse which starts the timing count in the display timer.

Assume that the word in the storage register had been 1 0 1 1 and the word requested by the consoles was still 1 0 1 0. Then, a +10-v output would have been obtained from AND circuit 4. After passing through OR circuit 5, this output would have been inverted. The resultant −30-v level would have blocked AND circuit 6. Any mismatch in the words will result in the output being blocked in a similar fashion.

Single-Message-Label Selector

Logic of the single-message-label selector is shown in Fig. 7. Selection of a single message label is performed in exactly the same manner as in the site-identity selector. Output of the site-identity selector is fed to the OR circuit shown in Fig. 6.

If an output is obtained from the multiple-message-label selector it is fed back to OR circuit 6 in the single-message-label selector. This level (+10 v) passes through the inverter and applies −30 v to the output AND circuit. This action blocks any output from the single-message-label selector and serves to interlock the two message-label selectors as a safety feature.

Multiple-Message-Label Selector

Logic of the multiple-message-label selector is shown in Fig. 8. This mode of operation can be selected at the console. Assume that the word requested by the consoles is 0 0 0 0 0. With the opposite voltage-level representation still being used, the levels are all +10 v. With the circuitry shown, an output will be obtained for all message labels representing odd binary numbers except 17 (1 0 0 0 1) and 19 (1 0 0 1 1). These last two numbers are used for height finder information and have no significance for the monitor.

If the conditions for message-label selection (Fig. 8) are examined closely, the following conditions are evident: A must always be a one (+10 v); B may be either a one or a zero (−30 v or +10 v); C is a zero whenever both B and D are zeros; D may be a one or a zero; and E is always a one. In Boolean notation, output of the circuit must be:

$$(A)\ (B + D + \bar{C})\ (E).$$

The notation on Fig. 8 indicates the manner in which this function is obtained with the circuitry shown.

Output of the multiple-message-label selector is fed to OR circuit 6, Fig. 7, to perform the interlocking function. Output is fed also to the OR circuit in Fig. 6 so that an intensification trigger pulse may be obtained if an output is available from the site-identity selector.

The binary decoder in the analog portion of the equipment, Fig. 9, performs a digital-to-analog conversion. Three decoders are used in the monitor—one each in the sin θ, cos θ, and range channels. Output of any one of the decoder units is a d-c level proportional to the digital data appearing at the input

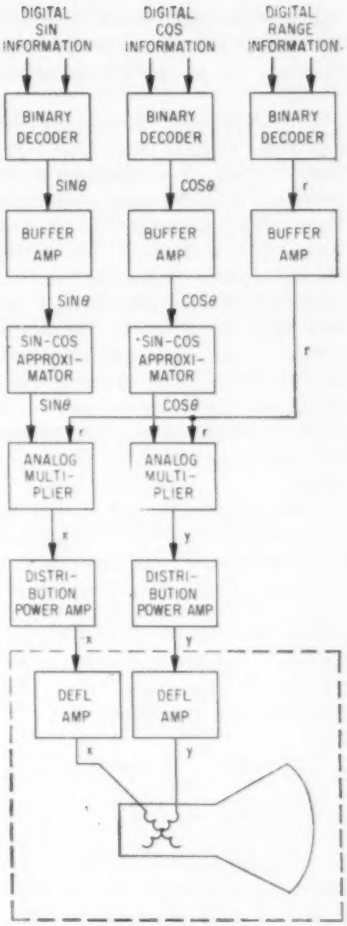


FIG. 9—Block diagram of analog portion of the monitor showing various operational stages

of the binary decoder unit.

Five basic circuits are used to perform the conversion. These are: two voltage reference sources, a constant-current source, a current-switching tube, and a resistive ladder network.

Decoder Circuitry

Figure 10 shows the circuitry for two of the 11 decoder stages. These two stages correspond to the two most significant bits of digital data presented to the decoder units. The decoder output voltage varies from +100 v (no digital input) to +150 v (all digital inputs present).

Part of the resistive ladder, R_1 through R_{11}, is shown at the top of Fig. 10. The ladder weights and sums the digital input so that the analog voltage output is propor-

tional to the input word. Summing takes place since there is one output terminal for the entire ladder network.

To understand the weighting function, assume that the right-hand halves of current-switching tubes V_1 and V_2 are conducting. Each tube draws the same current through the ladder. The ladder characteristics, however, are such that the drop associated with V_1 has only half the effect on the output voltage as the drop associated with V_2. The same effect exists in every section of the ladder so that the individual stages correctly represent the binary weighting of the digital input.

Tube sections V_{3A} and V_{3B} provide a constant-current source during the time that V_1 and V_2 draw current through the ladder network. Reference voltage 2 is supplied to the grids of V_3 to stabilize the operation. Calibration potentiometers are used in the cathodes of V_3 both for initial calibration and to correct for any long-term component drift. Constant-current sources described are used in the four most significant stages of the decoder. For the other seven stages, a regulated voltage reference is the only necessary control.

In V_1 and V_2, digital data are applied to the left-hand grids. When a digital zero is supplied to a decoder-stage input, it is desirable to have that stage draw current through the ladder network. Result of this mode of operation is that the output voltage will be low (+100 v) with all inputs zero (−30 v) and high (+150 v) with all inputs ones (+10 v). To obtain this mode, the right-hand grids of V_1 and V_2 are held constant at a regulated negative voltage (reference voltage 1).

When a zero is applied to any stage, the left side of that current-switching tube is cut off. The right side draws current through the ladder network, dropping the output voltage.

When a one is applied to the stage, the left side of the current-switching tube conducts, the right side is cut off. Output voltage rises according to the weight of that stage. Current drawn by the left side of the current switching tubes is bypassed around the resistor ladder network.

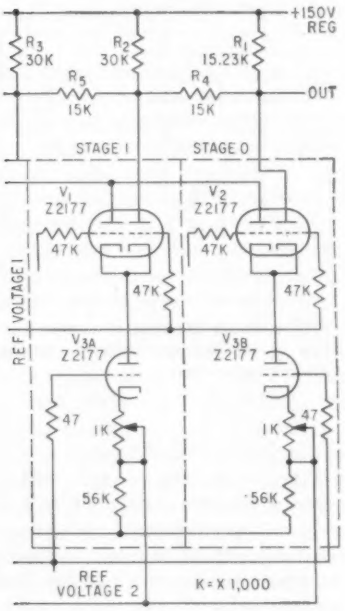


FIG. 10—Circuitry for two of the 11 decoders used

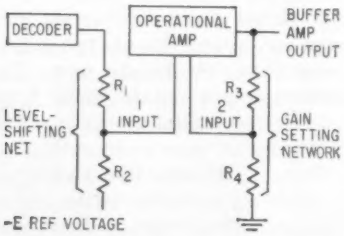


FIG. 11—Simplified circuitry for a buffer unit

Buffer Unit

Two voltage regulators and three operational amplifiers comprise the buffer unit. Each has its own level-shifting network, as shown in Fig. 11.

One amplifier and level-shifting network is used in each of the three signal channels (sin θ, cos θ and range).

Pure resistive coupling is used between the level-shifting network and the operational amplifier. Despite the signal attenuation present, this type of coupling is used to preserve the accurate signal level from the decoder output. Signal levels are shifted so that the sin and cos channels will have a range from −25 to +25 v as the azimuth increases from 0 to 360 deg. Also, it is necessary that the range channel vary from 0 to +50 v as the range increases from 0 to maximum. Level-shifting precision is maintained by 0.1-percent resistors. The resistive network is used also to provide the necessary fixed, high-resistance load for the decoders.

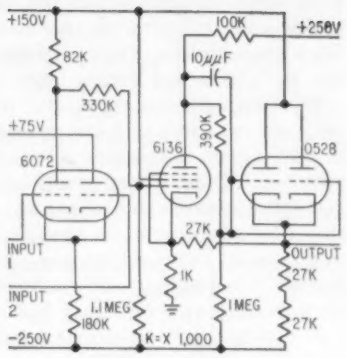


FIG. 12—Schematic diagram of an operational amplifier

Operational Amplifiers

Primary function of the operational amplifier is to provide a source capable of driving the varying input impedance of the sin-cos approximators. Gain lost in the level-shifting network is also made up in this stage. In the range channel, restoring the lost gain is the only function of that operational amplifier.

Operational amplifiers were selected because of the high precision obtainable. The amplifier has an open-loop gain in excess of 3,000 and a maximum theoretical error of 0.03 percent. The amplifier is actually operated at a net gain of only slightly greater than unity. Use of high-precision resistors in the negative feedback from the gain-setting network assures stability of the selected net gain regardless of any variation of tube parameters.

Several types of operational amplifiers are used. A schematic of a typical one is shown in Fig. 12. A differential-amplifier stage minimizes effects of tube drift. A pentode second stage with positive feedback and a cathode-follower output stage are used also. Regulated voltages are used in the input

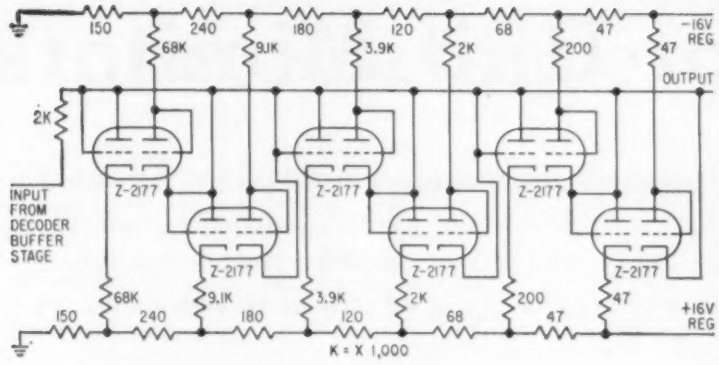


FIG. 13—Sin-cos approximator has circuitry shown

stage to minimize effect of any supply ripple at the output of the amplifier.

Output of the range buffer is fed directly to each of the analog multipliers. Sin and cos buffer outputs are fed to the sin sin-cos approximator and the cos sin-cos approximator.

Sin-Cos Approximator

The sin-cos approximator converts the first approximation of sin θ and cos θ to an accurate approximation of these functions. Conversion is accomplished by use of two diode function generators—one for positive signals, the other for negative signals. Circuitry is shown in Fig. 13.

Two voltage regulators are also associated with this circuit. Each supplies one of the reference voltages indicated.

Assume that information is entering the digital portion in the form of constantly increasing values of the azimuth angle θ. For any constant range, this information is displayed as a circle on the console. The first approximation of θ enters the sin-cos approximator as a triangular wave. It should be stated here that each cycle of the triangular wave consists of 4096 separate messages to the digital portion, one for each additional azimuth bit. The triangular wave is shaped to a sin (or cos) wave by the biased diodes. The diodes approximate the sin wave with a series of linear functions. The number of diodes used determines the accuracy of the approximation (one percent in the monitor). Diode-connected triodes were used.

Two analog multipliers are used in the monitor to convert the decoder range R and azimuth θ information into x and y coordinates. Specifically, one multiplier multiplies R by sin θ to obtain x. The other multiplies R by cos θ to obtain y.

The R data are obtained from the range-buffer amplifier and the sin and cos data are from the two sin-cos approximators. Multiplier outputs are fed to the distribution power amplifiers.

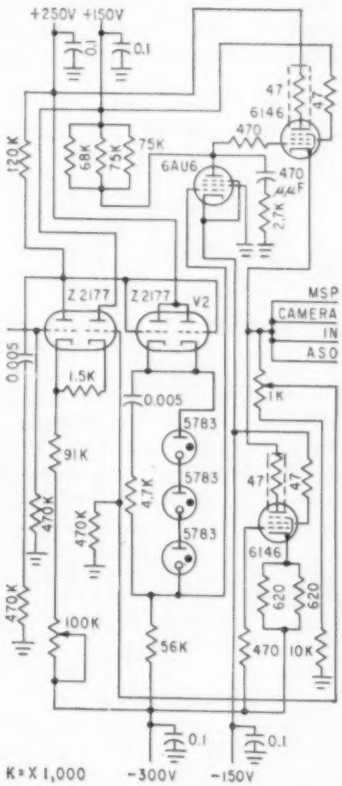


FIG. 14—Circuitry for distribution power amplifier

Polar coordinates used in the monitor are oppisite to the $x = R \cos \theta$ and $y = R \sin \theta$ seen generally in mathematics. If the usual coordinates were used, zero azimuth (at maximum range) would be displayed at the right side of the crt. Spots displayed at increasing azimuth angles would then appear in successive counter-clockwise positions. By changing the coordinates, zero azimuth or north (at maximum range) appears at the top of the crt. Increasing azimuth angles cause the spots to appear in successive clockwise positions.

Analog Multiplier

The analog voltage multiplier uses several operational amplifiers and associated network circuitry in a variation of the quarter-squared technique of multiplying two voltages. This technique uses the equation

$$xy = \tfrac{1}{4}\left[(x + y)^2 - (x - y)^2\right]$$

Squares of the sum and difference terms are formed accurately and synthetically without use of squaring devices. Operational amplifiers find the difference term and divide by four. The only satisfactory explanation of the multiplier operation is mathematical but will not be dealt with here.

Distribution Power Amplifier

The distribution power amplifier is an operational amplifier with an output capable of supplying high current with low output impedance. The output signal drives the deflection amplifiers in the consoles. A schematic of the distribution power amplifier is shown in Fig. 14. Regulators stabilize the internal voltages and several compensating networks maintain short rise and fall times. A large amount of negative feedback reduces the high open-loop gain to a closed-loop gain approaching unit. This stabilizes the selector net gain for tube parameter variations.

This equipment was developed by Bendix Radio on a subcontract under the auspices of IBM, Lincoln Laboratory and the USAF.

Transistor Unit Monitors

Continuous indication of blood pressure, with better than 3-percent full-scale accuracy, is obtained by using variable-reactance pressure transducer mounted in 5-cc syringe. Transistorized excitation supply amplifier and power-supply circuits permit packaging entire instrument in 8 by 10 by 10 inch unit

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Electromedical Project, National Research Council, Ottawa, Canada

RELIABLE AND ACCURATE methods of continuously measuring a patient's blood pressure during an operation have been provided for many years by commercial instruments. However, because operating room space is at such a premium it was felt that many of the bulky commercial models could be replaced by a transistorized monitor.

The instrument to be described has three ranges, 0 to 75, 0 to 150 and 0 to 300 mm of Hg; the mean blood pressure is indicated on a panel meter, while an additional output permits continuous recording of systolic and diastolic pressure variations. The complete instrument measures 8 by 10 by 10 in. and has a full-scale accuracy of better than 3 percent.

Basic Principles

By definition the maximum intra-arterial pressure during contraction of the heart, or the systole phase, is called systolic and the minimum pressure between relaxation and the start of the next heart contraction is called diastolic. The mean pressure is usually given as half the sum of the values for the systolic and diastolic pressures. A pressure introduced at the transducer effects an electrical relationship which is exactly proportional to the applied pressure.

The transducer, which is activated by a needle inserted directly into a patient's artery, is a commercially available variable-reactance unit that replaces the plunger

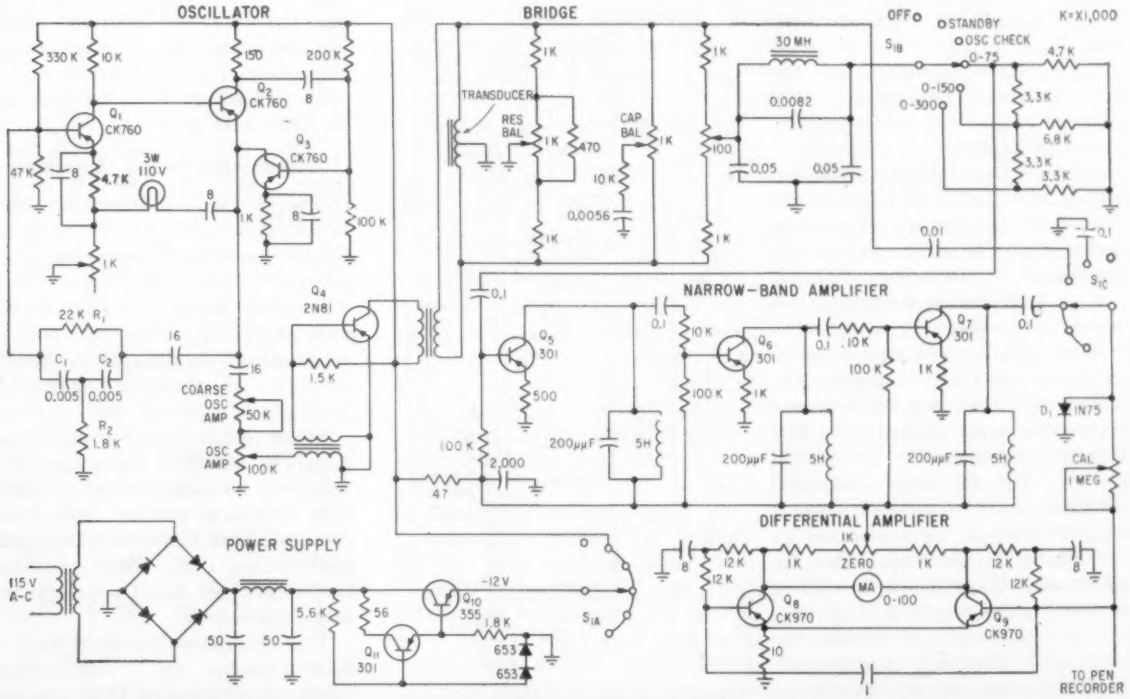


FIG. 1—Accuracy and repeatability of readings obtained with this circuit are limited only by characteristics of transducer used

Blood Pressure

in a 5-cc syringe. This assembly facilitates sterilization by solution or autoclaving. To prevent blood clotting, a three-way stopcock is used between the needle and the syringe for the introduction of anticoagulant solution.

Circuit

The transducer is excited by a low-distortion sine wave produced by the oscillator shown in Fig. 1. This circuit is the counterpart of the vacuum-tube Wien-bridge oscillator. Positive and negative feedback circuits generate a 5-kc, 1-v rms signal.

Frequency of oscillation is determined by the bridge circuit (R_1, R_2, C_1, C_2) in the negative-feedback loop. The amplitude of oscillation is stabilized by the lamp filament resistance in the positive feedback circuit. Power output stage Q_4 couples the oscillator to the low-impedance transducer bridge circuit.

With the bridge parameters shown and proper balancing procedure, the null potential can be made as low as 0.1 mv. The null point, although not absolute zero, is low enough to be negligible and serves as a reference for the output readings.

The signal from the bridge is fed through a range switch into a three-stage 5-kc amplifier comprising Q_3, Q_4 and Q_5; bandwidth and gain are shown in Fig. 2. Provision of sufficient negative feedback throughout the amplifier allows variations between transistors and provides good thermal stability.

The amplified pressure signal is rectified by D_1 and applied to the bases of Q_6 and Q_7. A microammeter is connected between the collectors. Silicon transistors are used because of their greater stability with temperature variations.

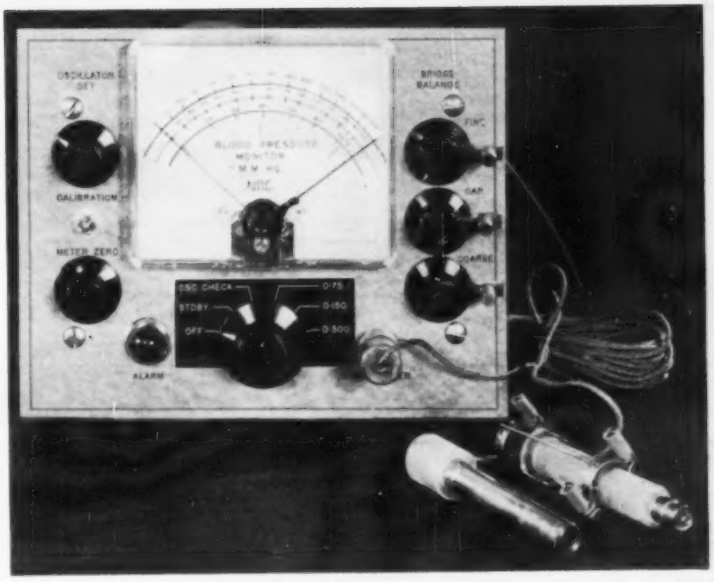
To obtain a true mean-pressure indication on the meter, the ripple voltage produced by the systolic and diastolic pressure variations is fed in phase to both sides of the differential amplifier through a large capacitor and thus does not affect the meter reading. However, a pen-recorder output is incorporated to obtain a record of systolic/diastolic pressure changes.

The constant-voltage transistor-regulated power supply produces −12 v at the load with better than 1-percent regulation for line variations of ±10 percent, and better than 5-percent regulation variations from zero to 100 ma.

Calibration

The instrument is calibrated by applying a known pressure on the transducer through a cuff manometer. With the range switch on the 0 to 75 mm range and a static pressure of 75 mm of Hg set by the cuff manometer, a full-scale reading is obtained by adjusting the current flowing into the base of Q_6 with the calibration potentiometer. Typical calibration curves for the instrument are shown in Fig. 3.

Accuracy and repeatability of readings are determined chiefly by the transducer used. With a Crescent type MPQ6 (0 to 300 mm Hg) transducer in the circuit, an accuracy of better than 3-percent full scale was obtained. The overall base-line drift, after a warmup period of two hours is less than 1 percent of the full-scale reading per hour.



Compactness, accuracy and dependability of unit make it ideal for operating-room service. Complete instrument measures only 8 by 10 by 10 in.

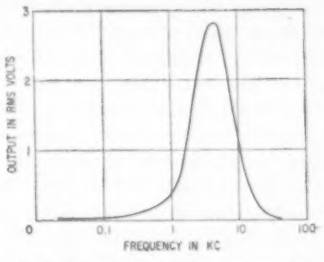


FIG. 2—Tuned amplifier response showing bandwidth and gain

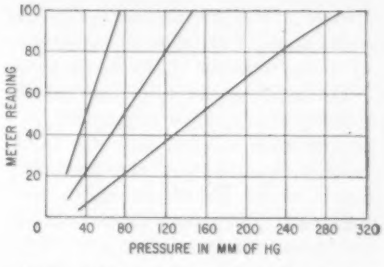
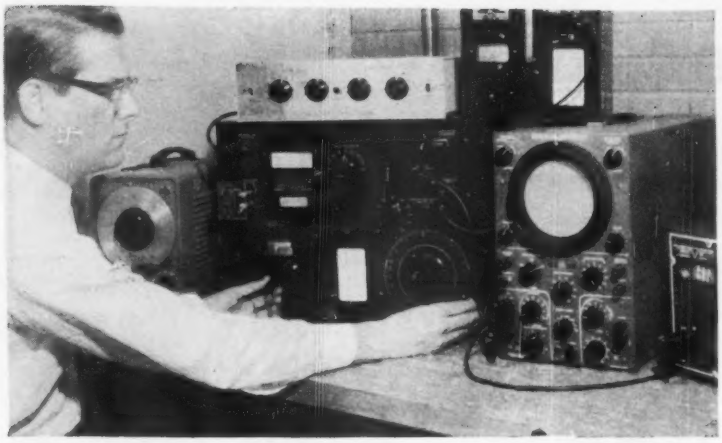


FIG. 3—Calibration curves for different operating ranges



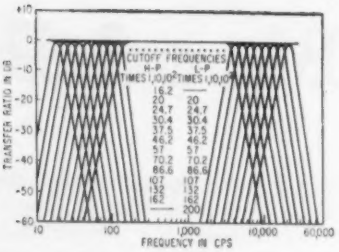


FIG. 1—High-pass and low-pass cutoff frequencies and ideal slopes

Bandpass filter in use in the laboratory, is the light-weight aluminum unit above the signal generator

Active Bandpass Filter

THERE ARE MANY applications for a small, adjustable audio bandpass filter having sharp cut-off characteristics. The filter described here is adaptable for sound analysis[1] and can be designed with fractional octave steps. Sharp cutoff slopes, wide dynamic range and low noise make it valuable for a variety of measurements in the audio field.

By making the filter active, all inductances could be eliminated, reducing size, weight, distortion and hum pickup while extending dynamic range. To obtain sharp corners and high cutoff slopes with a minimum of complication, both high-pass and low-pass sections of the filter were designed to achieve 7th-order Butterworth (maximally-flat) characteristics, giving cutoff slopes of 42 db/octave.

In a 7th-order filter of the type considered, seven elements must be varied simultaneously to alter the cutoff frequency. Because it is difficult to achieve accurate tracking of seven ganged elements, it was decided to change the cutoff frequency by switching the elements in discrete steps. Each decade is divided into eleven intervals, equally spaced on a logarithmic frequency scale. Thus, the ratio between two successive cutoff frequencies is $10^{1/11} = 1.23285$.

The selected frequencies and ideal cutoff characteristics are shown in Fig. 1. There are 34 separate high-pass cutoffs from 16.2 cps to 16,200 cps and 34 low-pass cutoffs running from 20 cps to 20,000 cps. The 12 cutoff frequencies within each frequency decade are obtained by switching resistor values while frequency multiplication factors of 10 and 100 are achieved by switching capacitors.

The absolute value of the input-output voltage transfer ratio, $S(j\omega)$, of a 7th-order low-pass Butterworth filter having unity transfer ratio in the pass region may be written as $|S(j\omega)| = [1 + \omega^{14}]^{-1/2}$, where the cutoff radial frequency ω_0 has been normalized to unity for convenience. As shown elsewhere[2],

Table I—Low-Pass Frequency-Determining Resistor Values

f_0 cps		$d = 1.802$		$d = 1.247$		$d = 0.445$	
	R_0	R_1	R_2	R_1	R_2	R_1	R_2
20	795.82	944.48	446.98	571.73	369.21	596.14	354.15
24.66	645.43	766	362.52	463.69	299.11	483.49	287.22
30.4	523.56	621.37	294.07	376.11	242.9	392.2	232.99
37.48	424.66	503.99	238.52	305.09	197.02	318.11	188.98
46.2	344.51	408.87	193.5	247.5	159.83	258.07	153.31
56.96	279.43	331.63	156.95	200.75	129.64	209.32	124.35
70.23	226.63	268.97	127.29	162.82	105.14	169.77	100.85
86.58	183.83	218.17	103.25	132.07	85.29	137.71	81.81
106.74	149.11	176.97	83.75	107.13	69.18	111.7	66.36
131.59	120.95	143.55	67.94	86.9	56.12	90.6	53.83
162.23	98.11	116.44	55.1	70.48	45.52	73.49	43.66
200	79.58	94.45	44.7	57.17	36.92	59.61	35.42

Table II—High-Pass Frequency-Determining Resistor Values

f_0 cps		$d = 1.802$		$d = 1.247$		$d = 0.445$	
	R_0	R_1	R_2	R_1	R_2	R_1	R_2
16.22	981.1	867.3	1109.8	587.1	1639.3	325.3	976.0
20	795.82	703.51	900.21	476.23	1329.7	263.87	791.68
24.66	645.43	570.57	730.10	386.23	1078.4	214.00	642.08
30.4	523.56	462.84	592.24	313.31	874.81	173.60	520.84
37.48	424.66	375.41	480.37	254.12	709.56	140.80	422.46
46.20	344.51	304.55	389.70	206.16	575.64	114.23	342.72
56.96	279.43	247.02	316.09	167.21	466.90	92.65	277.98
70.23	226.63	200.35	256.36	135.62	378.68	75.14	225.46
86.58	183.83	187.38	207.95	110.01	307.17	60.95	182.88
106.74	149.11	131.82	168.67	89.23	249.15	49.44	148.34
131.59	120.95	106.92	136.82	72.38	202.10	40.10	120.33
162.23	98.11	86.73	110.98	58.71	163.93	32.53	97.60

Use of active elements results in a lightweight, adjustable R-C audio filter having Butterworth attenuation characteristics and 42 db/octave cutoff slopes. Filter supplies more than 50 volts rms output with low distortion and has dynamic range exceeding 100 db. Second-order harmonic distortion is considerably reduced by operating tube heaters at low voltage

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Has Sharp Cutoff

the transfer ratio itself may be written in terms of the complex frequency variable p (equal to $\sigma + j\omega$, where σ is a small constant) as $S(p) = [(p+1)(p^2 + d_1p + 1)(p^2 + d_2p + 1)(p^2 + d_3p + 1)]^{-1}$, with $d_m = 2\cos(\pi m/7)$ for $m = 1, 2, 3$. These values of d_m (1.802, 1.247, and 0.445) cause the complex-conjugate poles of $S(p)$ to lie equally spaced on the left half of a unit-radius circle in the p plane with center at $p = 0$. There is also a pole at $p = -1$. This distribution of poles results in Butterworth, or maximally flat, response. For high-pass response, there is a 7th-order zero at $p = 0$ in addition.

One of the easiest ways of realizing the above form of $S(p)$ is to use a separate circuit to achieve each term in parentheses in the expression for $S(p)$. These circuits must, of course, be isolated from each other. The term $(p+1)^{-1}$ is produced merely by a single R-C time constant. The other terms may be realized in a variety of ways.

Results of previous work[3] lead to the simple feedback circuits of Fig. 2. The active elements with voltage transfer ratios of K should, ideally, have infinite input and zero output impedances. They then give perfect isolation between stages. For practical purposes, cathode followers may be used as long as the required K is less than unity.

Equations relating the d's, K's, and frequency-determining resistor and capacitor values have been given and are discussed in connection with the detailed circuit design of the present filter elsewhere.[2, 3] Tables I and II show the calculated frequency determining resistor values. Resistor values were selected to within 2 or 3 percent of nominal and the capacitor values to within 1 percent, Table III.

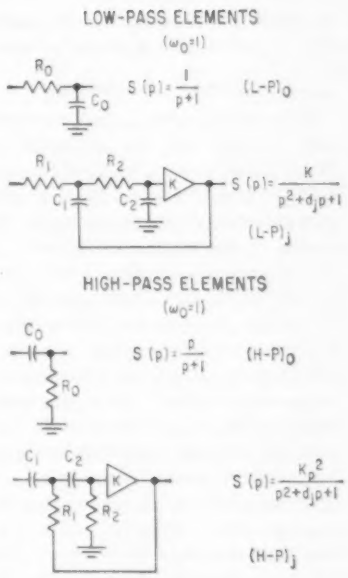

FIG. 2—Elemental frequency-determining circuits with feedback

Table III—Active-Element Transfer Ratios, K, and Frequency-Determining Capacitor (μf) for the Lowest Decade

d	K		C_0		C_1		C_2	
	LP	*HP*	*LP*	*HP*	*LP*	*HP*	*LP*	*HP*
.....	0.97	0.97	0.01	0.01	.....	.....	.....	.....
1.802	0.97	0.97	.....	.....	0.015	0.01	0.01	0.01
1.247	0.97	0.97	.....	.....	0.03	0.01	0.01	0.01
0.445	1.333	1.300	.....	.....	0.03	0.01	0.01	0.03

Figure 3 shows the circuit of the filter with switches for changing resistor and capacitor values omitted. The switches shown allow the low-pass and the high-pass sections to be used in series, either section separately, or neither section. The low-pass section is entirely direct coupled and could be employed separately as a direct-coupled filter.

Augmented cathode followers

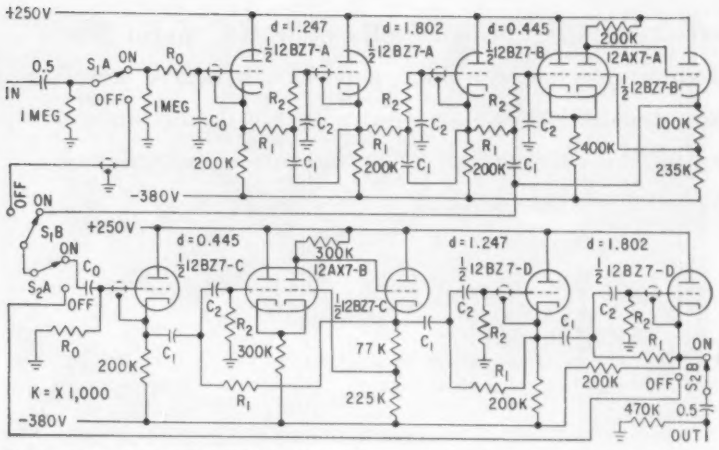

FIG. 3—Filter circuit with switching of frequency-determining elements omitted

(acf)[4] which have low output impedances and voltage transfer ratios which may be made greater than unity are used. The filter was actually designed with all cathode follower K's equal to 0.97 and with the low- and high-pass acf's having K's of 1.33 and 1.3, respectively.

Cathode Followers

The 12BZ7 cathode followers used were found to be superior to 12AT7's in having an input-output voltage transfer ratio nearer unity and a lower output impedance. The factor K varied from 0.98 with an added output load of 115,000 ohms to 0.96 with an added load of 15,000 ohms. Because switching of the frequency determining resistors puts a varying load on the cathode-follower circuits, it is desirable to pick the impedance level such that the change from minimum to maximum load alters K as little as possible since the d factors which determine filter response depend on the K's. On the other hand, with too high an impedance level, the effect of stray capacitances will become important at high frequencies.

The impedance level has been selected so that all cathode-follower K's lie between about 0.982 and 0.97. Frequency-determining resistance values then lie between 1.1 megohm and 32,000 ohms. The actual small variations of K with load have been found to exert negligible effect on the filter characteristics. The output impedances of the two acf's used are so low that variable loading has no measurable effect on their K values. Values of K greater than unity are achieved here by tapping down the feedback line on the output cathode resistor. Distortion is low in the acf circuits and, like cathode followers, they produce no phase inversion.

In the cathode follower circuits, the input shields are driven by the output. Since the output is in phase with and almost equal to the input, this technique reduces the effect of stray capacitance to ground and of capacitance between shield and input appreciably. The minimum input resistance of the filter is about 80,000 ohms. It could be made much greater by using a separate input isolation stage. The output resistance is about 350 ohms. By placing an acf last, it could be reduced to about 5 ohms; it was felt more desirable, however, to use the low acf output resistance to drive frequency-selective elements instead of the output.

Performance

Before measurement of filter performance, the two acf K-values were adjusted to give the closest approximation to maximally flat or Butterworth response in the neighborhood of all of the cutoff frequencies. Although the many frequency determining resistance values were selected to within only two or three percent tolerance, it was found that all cutoff regions approximated ideal Butterworth response to within ±1 db and that many were much closer than that to ideal. Only when several of the resistance tolerances were off in the same direction did as much as a 1 db deviation above or below ideal response occur. In the majority of the cases, resistance deviations in opposite directions cancelled out.

The input-output voltage transfer ratio of the low-pass section was found to be 1.33 while that of the high-pass section was 1.26, making the voltage amplification ratio of both sections in series 1.68. These results apply for all positions of the low-pass section but are slightly altered for the $f \times 100$ position of the high-pass section. There, the high-pass voltage transfer ratio is reduced by 4 db compared to the $f \times 1$ and $f \times 10$ positions. This reduction is independent of cutoff position (resistance values) and arises from unavoidable stray capacitance to ground. The effect could have been reduced or eliminated entirely by making all high-pass capacitance values ten times larger and all resistance values ten times smaller. This reduction in impedance level would have caused appreciable change in cathode follower K's with cutoff position, however, because of the increased loading and would have necessitated replacement of these cathode followers by acf's if no change of high-pass voltage transfer ratio and corner shape with cut-off position were required.

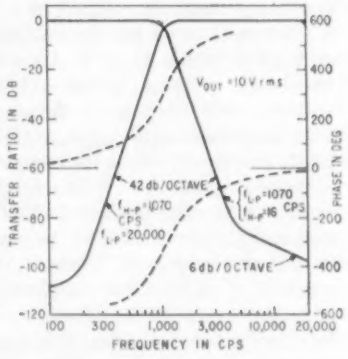

FIG. 4—Typical amplitude and phase characteristics of the filter

The impedance level is similarly high in the low-pass section, but voltage amplification reduction in the $f \times 100$ position can be eliminated since the important stray capacitance is there in parallel with the frequency-determining capaci-

tances. By using variable trimmer capacitances in the $f \times 100$ position, the values of all C_0, C_1, and C_2 capacitances can be set once and for all to their correct values, including stray capacitance effects, to yield Butterworth response.

Phase and Amplitude

Typical amplitude and phase characteristics for two different settings of the filter are shown in Fig. 4. Because of unavoidable harmonic distortion in the oscillator used, the high-pass amplitude characteristic with high-pass cutoff frequency $f_{H\text{-}P}$ = 1,070 cps, low-pass cutoff $f_{L\text{-}P}$ = 20,000 cps had to be measured with a wave analyzer. The low-pass characteristic could be measured with either the wave analyzer or a wide-band a-c voltmeter. Phase was measured with a phasemeter. The intrinsic noise output of the filter set for maximum bandpass

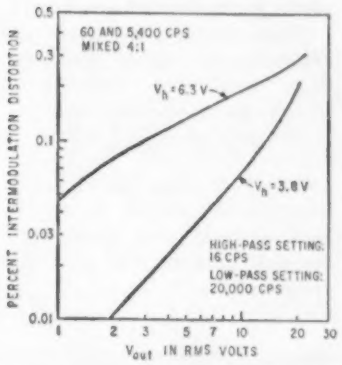

FIG. 5—Intermodulation distortion versus output voltage for two heater voltages

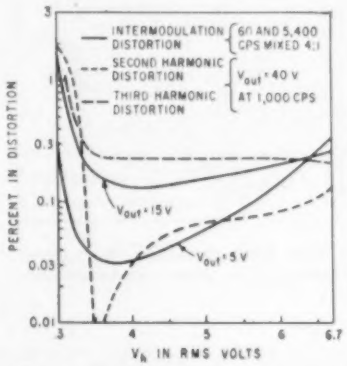

FIG. 6—Intermodulation and harmonic distortion versus heater voltage

($f_{H\text{-}P}$ = 16 cps, $f_{L\text{-}P}$ = 20,000 cps) was less than 100 μv rms measured with a wide-bandwidth voltmeter.

The residual 6 db/octave slope in the low-pass characteristics of Fig. 4 arises from feedthrough. These results suggest that if the impedance level in the low-pass section were reduced by making all frequency determining capacitors larger and all resistors smaller by a factor of ten, an increased region of attenuation of 42 db/octave slope in the $f \times 100$ and $f \times 10$ positions could be achieved.

The amplitude response curves of Fig. 4 are within better than 1 db of ideal Butterworth response over their entire regions until the final high-attenuation curvature sets in. Since the attenuation at cut-off should be 3 db, when both low-pass and high-pass sections are set to the same cutoff frequency the combined attenuation should be 6 db at the peak of the resulting inverted V characteristic. In the large majority of cases, the attenuation is 6 db ±1db; in a few cases, the deviation may be as large as ±2 db.

The upper dashed phase curve of Fig. 4 is associated with the low-pass amplitude curve. It approaches a high-frequency limiting value of 560 deg, while the lower phase curve approaches a value of −560 deg. These phase shifts are appreciable. Others have shown[5] that tremendous phase shifts are required to cause audible effects.

It has already been mentioned that when $f_{H\text{-}P}$ and $f_{L\text{-}P}$ are set equal, the resulting characteristic is an inverted V with 42 db/octave side slopes. When the high- and low-pass cut-offs are separated by one step, the top of the characteristic is more rounded and is about 1.2 db under the normal transmission of the filter. With two or more steps between high- and low-pass settings, the top of the band-pass characteristic is not reduced compared with the normal transmission and it shows a definite flat portion with three or more steps.

The dynamic range of the filter is great. Because of the use of cathode followers and acf circuits, it will handle an output of more than 50 v rms without appreciable distortion. The total dynamic range therefore exceeds 110 db. Having no inductors, the filter is not susceptible to hum pickup from magnetic fields.

Figure 5 shows the measured intermodulation distortion of the filter for two different heater voltages applied to all tubes. The effect of heater voltage in reducing distortion is clarified in Fig. 6. These measurements show that the third harmonic distortion is virtually independent of heater voltage (or current) until such low voltages are reached that cathode emission drops rapidly. Similarly, the fundamental component is independent of heater-voltage until this level is reached. On the other hand, the second harmonic goes virtually to zero just before the point is reached where the emission drops quickly.

Since the second harmonic is the major harmonic component at the lower output voltages. Figs 5 and 6 show that the intermodulation distortion is also appreciably reduced at the lower outputs by reducing the heater voltage to the region where second-harmonic distortion is negligible. This conclusion is also borne out by the different slopes of the two curves of Fig. 5. The low distortion values shown in Figs. 5 and 6 also depend on proper selection of the positive and negative supply voltages.

Second-harmonic cancellation of the above form arises from a dependence of the input-output transfer characteristics of the various tubes of the filter on cathode temperature. At a certain temperature, the curvatures of these characteristics are apparently just right to yield a combined characteristic with no second-order harmonic-generating components over quite a wide dynamic range. Since the specifications of the filter are improved by operation with 3.5 - 3.8 volts on the heaters, it is run at that level.

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(1) H. H. Scott and D. Von Recklinghausen, A Compact, Versatile Filter-Type Sound Analyzer, *Jour Acoust Soc Am* **25**, p 727, July 1953.
(2) J. R. Macdonald, Active, Adjustable Audio Band-Pass Filter, *Jour Acoust Soc Am* **29**, p 1348, Dec. 1957.
(3) R. P. Sallen and E. L. Key, A Practical Method of Designing RC Active Filters, *Trans IRE* **CT-2**, p 74, Mar. 1955.
(4) J. R. Macdonald, Some Augumented Cathode Follower Circuits, *Trans IRE* **AU-5** p 67, May-June 1957.
(5) J. Moir, Phase Shift and Sound Quality, *Wireless World* **62**, p 165, Apr. 1956.

Amplifier Delay Charts

Curves presented here permit rapid determination of time delay through various types of amplifiers when only desired bandwidth is known. Most desirable amplifier type for a given design can be found directly from a universal chart especially applicable to computers and radar

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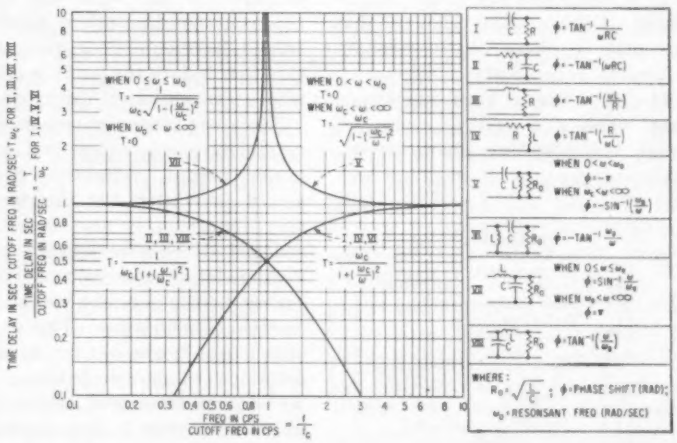

TIME DELAY IN SEC X CUTOFF FREQ IN RAD/SEC = T ω_c FOR II, III, IV, VIII
TIME DELAY IN SEC / CUTOFF FREQ IN RAD/SEC = T / 1/ω_c FOR I, IX, V, VII
WHEN 0 ≤ ω ≤ ω_0
T = 1 / ω_c √(1-(ω/ω_c)^2)
WHEN ω_0 < ω < ∞
T = 0
WHEN 0 < ω < ω_0
T = 0
WHEN ω_c < ω < ∞
T = ω_c / ω √(1-(ω_c/ω)^2)
T = 1 / ω_c [1+(ω/ω_c)^2]
T = ω_c / ω^2 / 1+(ω_c/ω)^2
FREQ IN CPS / CUTOFF FREQ IN CPS = f / f_c
I φ = TAN^-1 1/ωRC
II φ = -TAN^-1 (ωRC)
III φ = -TAN^-1 (ωL/R)
IV φ = TAN^-1 (R/ωL)
V WHEN 0 < ω < ω_0 φ = -π
WHEN ω_c < ω < ∞ φ = -SIN^-1 (ω_0/ω)
VI φ = -TAN^-1 ω_0/ω
VII WHEN 0 ≤ ω ≤ ω_0 φ = SIN^-1 ω/ω_0
WHEN ω_0 < ω < ∞ φ = π
VIII φ = TAN^-1 (ω/ω_0)
WHERE: R_0 = √(L/C) ; φ = PHASE SHIFT (RAD); ω_0 = RESONSANT FREQ (RAD/SEC)

FIG. 1—Time delay curves for networks. Time delay characteristics produced in ordinary R-L-C networks are important design factors. Many applications use linear delay dispersion plotted above

SMALL TIME DELAYS present in vacuum tube amplifiers determine the correct temporal relationship between two or more signals. This delay time is composed of two parts—actual transit time in tubes and components and delay resulting from phase shift through the circuit.

Since transit time delays are insignificant, this discussion deals only with phase shift effects. Basic equation used is

$$T = t_{out} - t_{in} = -\frac{d\phi}{d\omega}$$

where T is time delay, t_{out} is time out of network, t_{in} is time into network, ϕ is phase shift through network and ω is any frequency.

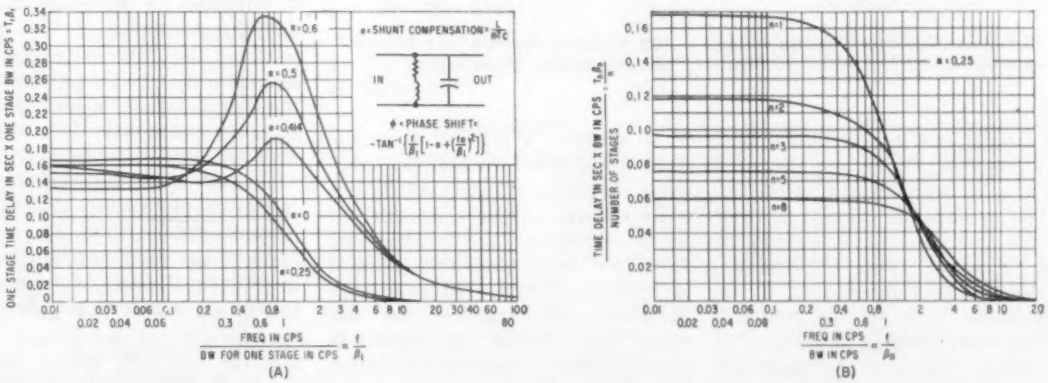

ONE STAGE TIME DELAY IN SEC X ONE STAGE BW IN CPS = T_1 β_1
α = 0.6
α = 0.5
α = 0.414
α = 0
α = 0.25
α = SHUNT COMPENSATION = 1/R^2C
IN
OUT
φ = PHASE SHIFT = -TAN^-1 (1/β_1 [1-α+(1/2 β_1^2)])
FREQ IN CPS / BW FOR ONE STAGE IN CPS = f/β_1
(A)
TIME DELAY IN SEC X BW IN CPS = T_n β_n / NUMBER OF STAGES
n=1
n=2
n=3
n=5
n=8
α = 0.25
FREQ IN CPS / BW IN CPS = f/β_n
(B)

FIG. 2—Time delay curves for video amplifiers. Video amplifiers can be common R-C amplifiers or compensated types which provide bandwidth improvement and faster rise time. Time delay curves for various degrees of shunt compensation are plotted in (A). For the uncompensated case, the time delay variation across the bandwidth is 50 percent while for 0.25 shunt compensation the variation is only 41 percent. Shunt compensation greater than 0.25 produces larger and more positive time delays. Time delay curves for *n*-cascaded shunt compensated stages plotted in (B) show the relationship between time delay variation, overall bandwidth and number of stages. Delay variation across the band decreases with increasing numbers of stages because of bandwidth shrinkage. Time delay for a number of stages can be determined readily from curves with only knowledge of overall bandwidth and number of stages

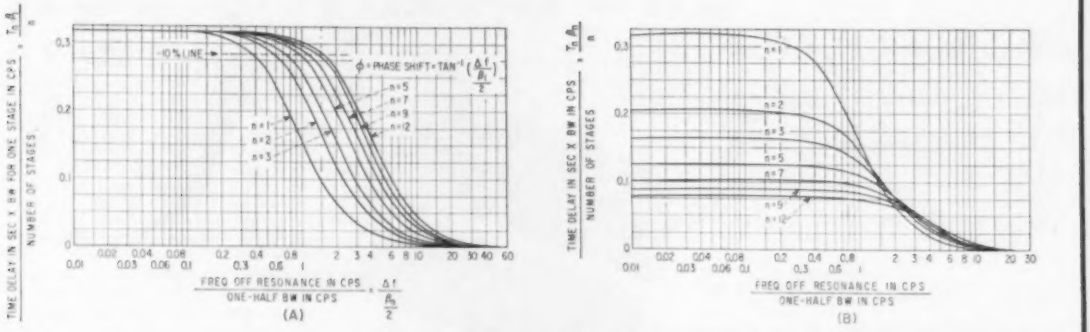


FIG. 3—Time delay curves for synchronously tuned bandpass amplifiers. Time delay through single-tuned i-f amplifiers containing n stages is plotted in (A). This chart is normalized to the bandwidth of a single stage to show flattening of time delay variation across overall bandwidth when number of stages is increased. Time delay distortion of a broadband signal is smallest when a large number of cascaded stages is used. For example, variation across the band for a single stage is 50 percent while for three stages is only 19 percent. In narrow-band i-f strip design, therefore, it is not advantageous to make one stage the bandwidth determining stage unless the associated time delay distortion can be tolerated. Time delay variation as a function of overall bandwidth is plotted in (B). Only overall bandwidth and number of stages must be known to determine the overall time delay. In a strip having stages of unequal bandwidths, overall delay can be calculated by adding delays for each bandwidth.

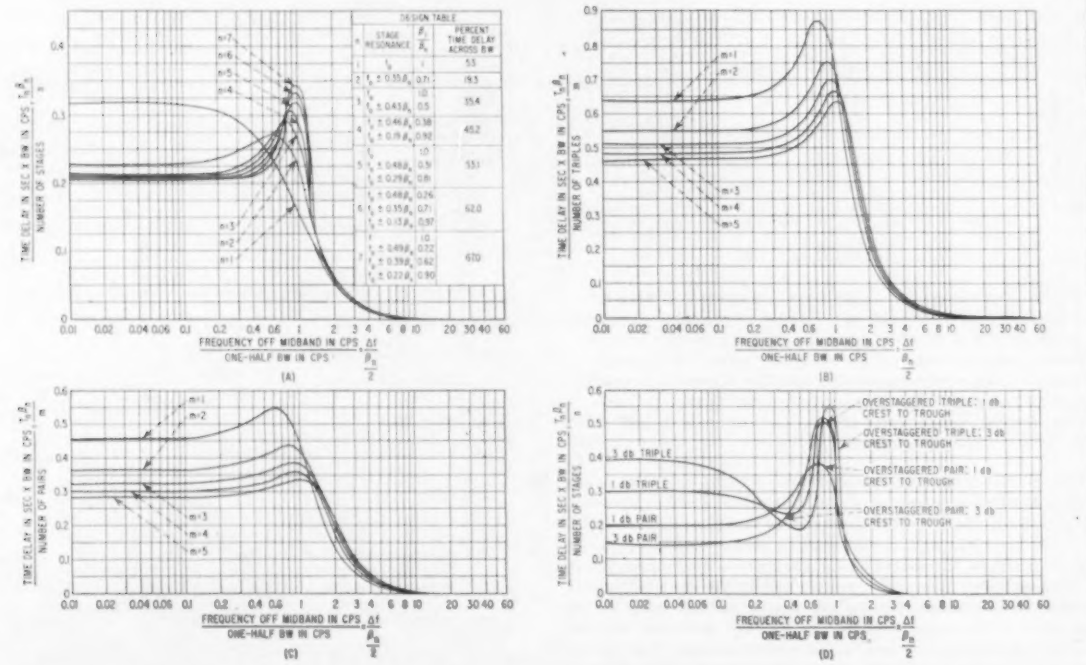

DESIGN TABLE
STAGE RESONANCE
PERCENT TIME DELAY ACROSS BW
n=1
n=2
n=3
n=4
n=5
n=6
n=7
m=1
m=2
m=3
m=4
m=5
3 db TRIPLE
1 db TRIPLE
1 db PAIR
3 db PAIR
OVERSTAGGERED TRIPLE: 1 db CREST TO TROUGH
OVERSTAGGERED TRIPLE: 3 db CREST TO TROUGH
OVERSTAGGERED PAIR: 1 db CREST TO TROUGH
OVERSTAGGERED PAIR: 3 db CREST TO TROUGH
FREQUENCY OFF MIDBAND IN CPS / ONE-HALF BW IN CPS = Δf/(Bn/2)
TIME DELAY IN SEC X BW IN CPS / NUMBER OF STAGES = τnBn/n
TIME DELAY IN SEC X BW IN CPS / NUMBER OF TRIPLES = τnBn/m
TIME DELAY IN SEC X BW IN CPS / NUMBER OF PAIRS = τnBn/m
TIME DELAY IN SEC X BW IN CPS / NUMBER OF STAGES = τnBn/n
(A)
(B)
(C)
(D)

FIG. 4—Time delay curves for stagger-tuned amplifiers. Stagger-tuned amplifiers are used when large bandwidths are required. The product of overall bandwidth and mean stage gain for a flat, staggered n-uple is the same as the gain bandwidth product for a single tuned circuit. Main advantage of this circuit is that the bandwidth shrinkage of m cascaded flat staggered n-uple is much smaller than the shrinkage which occurs in n cascaded single-tuned circuits. Time delay curves for a flat, staggered n-uple designed from tabulated values are shown in (A). The only cases which have less than the synchronously tuned delay are the flat staggered pair and the flat staggered triple. Time delay for m flat, staggered triples and pairs as functions of overall bandwidth are shown in (B) and (C). Overstaggered n-uples are sometimes used where even wider bandwidths for a given gain are required and slight dips in the bandpass can be tolerated. An overstaggered n-uple can be designed from the flat-staggered n-uple design table in (A) by leaving the individual resonant frequencies unaltered and narrowing the individual bandpasses by the same ratio. Overall bandpass will be virtually unaltered, but gain will increase proportionately. Time delay curves for over-staggered pairs and triples with one and three db dips are overall delay can be be calculated by adding delays for each bandwidth. **(continued on p 90)**

Amplifier Delay Charts (continued from p 89)

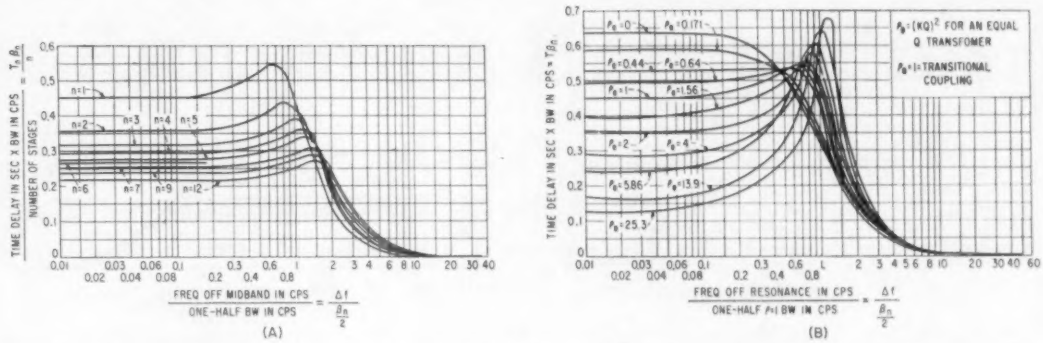


FIG. 5—Time delay curves for double-tuned circuits. Main advantages of transformer coupled tuned circuits over single-tuned circuits are the higher gain-bandwidth product, the steeper skirt selectivity and the lower bandwidth shrinkage with cascaded stages. Improvement in gain-bandwidth product depends on the Q ratio of primary and secondary windings and varies from $\sqrt{2}$ with equal primary and secondary Q's to 2 with one of the Q's infinite, that is, one side loaded. For a given bandwidth, selectivity curve is constant with variation of Q ratio.

Time delay curves for transitionally coupled double-tuned circuits are plotted in (A). For a single stage, only 20 percent time delay variation exists over the 3 db bandwidth as compared with 50 percent for a single-tuned stage. For three stages, however, the single-tuned delay variation is down to 19 percent while the variation in the double-tuned case is decreased to only 22 percent. High bandwidth shrinkage rate tends to flatten the delay variation across the 3-db bandwidth of a number of single-tuned amplifiers. Delay characteristics change for nontransitional couplings. Time delay curves for various degrees of coupling are plotted in (B). Quantity β is normalized to that obtained with transitional coupling

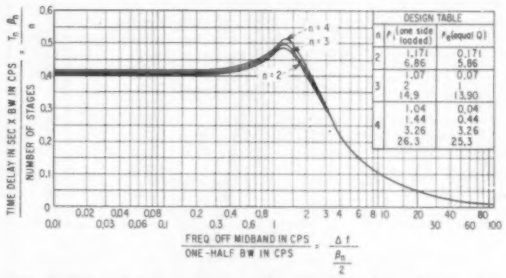
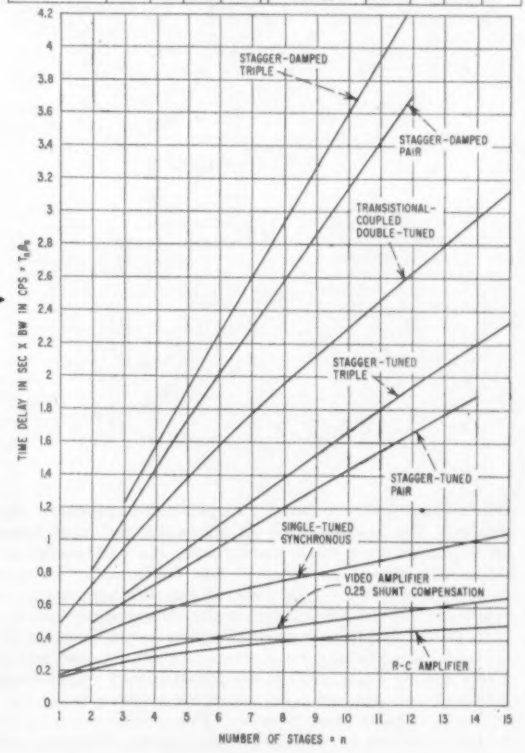

TIME DELAY IN SEC X BW IN CPS = $\frac{T_n \beta_n}{n}$ = NUMBER OF STAGES
n=4
n=3
n=2
FREQ OFF MIDBAND IN CPS / ONE-HALF BW IN CPS = $\frac{\Delta f}{\frac{\beta_n}{2}}$
DESIGN TABLE
n | β_n (one side loaded) | β_n (equal Q)
2 | 1.171 | 0.171
2 | 6.86 | 5.86
3 | 1.07 | 0.07
3 | 2 | 1
3 | 14.9 | 13.90
4 | 1.04 | 0.04
4 | 1.44 | 0.44
4 | 3.26 | 3.26
4 | 26.3 | 25.3

FIG. 6—Time delay curves for stagger damping. A plan for broadening the bandwidth of a number of cascaded double-tuned circuits is called stagger damping. It consists of cascaded undercoupled and overcoupled circuits. A properly designed, flat, stagger-damped n-uple has a product of overall bandwidth and mean stage gain equal to that of a one-side, loaded double-tuned circuit. Curves were based on data shown in design table

FIG. 7—Universal time delay curves. When signals are in the form of voltage pulses, amplifier delay time can be important. Pulse delay time, as defined here, is the time difference between the input and output leading edges measured at the point which is 50 percent of the peak pulse amplitude. Correlation of delay time with overall bandwidth and number of stages is accomplished in the universal amplifier delay curves at right. If the amplifier type, the number of stages, and the overall bandwidth are known, the amplifier delay time can be found directly. For example: an eight-stage synchronously tuned amplifier having an overall bandwidth of one mc produces a delay time of 0.755 μsec, while a shunt compensated video amplifier of the same overall bandwidth and number of stages has a delay of 0.48 μsec. The curves apply only for cascaded stages or n-uples of equal bandwidth. If unequal bandwidths are used, the overall bandwidth is the sum of the delays at each bandwidth as determined separately from the universal curve. Assume that an amplifier of known time delay is required with a gain of 80 db, a bandwidth of four mc and cascaded 5654 tubes. The 100-db, 80-mc circuit with the shortest delay turns out to be the seven-stage R-C amplifier while a three-stage, stagger-damped triple gives the longest delay

DESIGN TABLE

AMPLIFIER	STAGES	GAIN (DB)	$T_n\beta_n$	T_n	AMPLIFIER	STAGES	GAIN (DB)	$T_n\beta_n$	T_n
R-C	7	86	0.37	0.093	STAGGER-TUNED TRIPLE	3	65	0.68	0.170
VIDEO (α=0.25)	5	89	0.38	0.095		6	123	1.10	0.275
SINGLE-TUNED SYNCHRONOUS	6	76	0.666	0.167	STAGGER-DAMPED PAIR	2	56	0.81	0.203
	7	84	0.71	0.178		4	107	1.45	0.363
STAGGER-TUNED PAIR	4	79	0.73	0.182	STAGGER-DAMPED TRIPLE	3	83	1.23	0.308



NEW CINCH

HINGE CONNECTORS

PLUG AND SOCKET SHOWING CONTACT ARRANGEMENT
Patent Pending

The top section of the lock fits into a slot in the top of the cap forming a perfect lock which cannot be accidently opened, as shown below. Lifting up top section releases same prior to unlocking.

INSURE POSITIVE CONTACT; HAVE SIMPLE LOCKING DEVICE, EASY RELEASE. MAXIMUM NUMBER OF CONTACTS IN MINIMUM SPACE

The plug and socket units of the "H" Series are easily engaged with normal pressure and the lock holds them securely together. Releasing the lock the units separate by the spring action of the contacts. A simple locking device insures positive contact. Wiping contact action keeps contacts clean at all times. Either the plug or socket body fit into the cap. Cable entrance hole can be placed at the one end, or in the top, or both. Cover is finished in black wrinkle and the cable clamps are cadmium plated. Contact tails will take either conventional solder wiring or AMP "78" series Taper Tab receptacles.

Socket with Lock

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24492	20	1.375	1.750
24493	30	1.812	2.187
24494	40	2.250	2.625
24495	50	2.687	3.062
24496	60	3.125	3.500
24497	70	3.562	3.937
24498	80	4.000	4.375
24499	90	4.438	4.812
24500	100	4.875	5.250

Socket without Lock

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24484	20	1.375	1.750
24485	30	1.812	2.187
24486	40	2.250	2.625
24487	50	2.687	3.026
24488	60	3.125	3.500
24489	70	3.562	3.937
24413	80	4.000	4.375
24490	90	4.438	4.812
24491	100	4.875	5.250

Plugs without Lock—Mates with above

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24501	20	1.375	1.750
24502	30	1.812	2.187
24503	40	2.250	2.625
24504	50	2.687	3.062
24505	60	3.125	3.500
24506	70	3.562	3.937
24507	80	4.000	4.375
24508	90	4.438	4.812
24509	100	4.875	5.250

Plug with Lock—Mates with above

Code No.	Contacts	Dimensions Mtg. Centers	Overall
24476	20	1.375	1.750
24477	30	1.812	2.187
24478	40	2.250	2.625
24479	50	2.687	3.026
24480	60	3.125	3.500
24481	70	3.562	3.937
24412	80	4.000	4.375
24482	90	4.438	4.812
24483	100	4.875	5.250

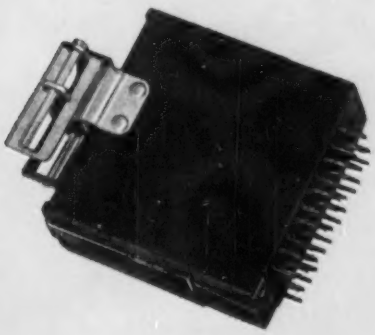
The plug or socket bodies can be ordered from the code numbers listed. The one that is attached to the chassis should have the lock attached. If an insulating liner is required in the cover, suffix L should be added to the Code Number.

The cap is ordered according to the number of contacts required. Then the letter L designating the liner. The letter giving hole size follows. Then the letter indicating the location of the hole; either T for top, or E for end, and if a cable clamp is required, the letter C is added.

For example, if a 50 contact unit is required with cover, having a ¾" hole in the top with a cable clamp and liner, the code would be 24540-LBTC. The chassis socket would be 24495 and the plug for the cap 24504.

The Cinch "H" series is made in 20 to 100 contacts, in multiples of 10 contacts.

50 CONTACT ASSEMBLY WITH CABLE CLAMP



Caps for Plugs or Sockets without Locks

Code No.	Contacts	Hole Size	Mtg Ctrs	Overall
24537	20	A or B	1.375	1.750
24538	30	A B or C	1.812	2.187
24539	40	B or C	2.250	2.625
24540	50	B or C	2.687	3.062
24541	60	B C or D	3.125	3.500
24542	70	B C or D	3.562	3.937
24543	80	B C or D	4.000	4.375
24544	90	C D or E	4.437	4.812
24545	100	C D or E	4.875	5.250

Cap Hole Size		Cable Clamp Size
Letter	Dimension	
A	⅛" dia.	Small
B	¼"	Small
C	13/16 x 1	Medium
D	13/16 x 1½	Medium
E	13/16 x 1-11/16"	Large

Electrical Rating

	Volts ACRMS	DC
Adjacent Terminals	930	1300
to Ground	1400	2000
Current Rating	4.5 Amperes	
Contact Resistance rated current @	.020 ohms	
Insulation Resistance	1000 megohms	
Capacitance adjacent contacts	.75 MMF	

Components shown reduced in size

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La Puente, California;
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Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

CIRCLE 61 READERS SERVICE CARD

Radiometer Studies Atmosphere

RADIO ASTRONOMY techniques were used to measure atmospheric absorption, refraction and scintillation at 4,700 mc (C band). The sun served as the source of r-f energy. The measurements were made with a comparison-type radiometer using traveling-wave tubes in a trf receiver, instead of a superheterodyne circuit.

The three-stage traveling-wave amplifier used in the system, shown in Fig. 1, has a center frequency of 4,700 mc. An 800-mc bandwidth filter and a detector follow the trf sections.

A 30-cps mechanical chopper switches between the antenna and the 300-degree K black-body matched-load signal. A 16-db noise tube and suitable precision attenuator are used to check system operation and furnish temperature calibration for signals.

Output from the filter and synchronous detector is fed through the integrator unit to a recording milliammeter with a 0.5-sec time constant.

The basic advantage of the traveling-wave tube radiometer lies in its wide band. The wider band increases sensitivity of this system, since minimum detectable signal is inversely proportional to the square root of bandwidth. Therefore, the sensitivity of this unit is five times that of the 10-mc superheterodyne (actually, an effective 20 mc in this receiver, since both sidebands are used in the superheterodyne).

In initial equipment tests in 1955, this system was found necessary because, without the comparison feature, long-term drift was considerable. In the tests made with the traveling-wave tube radiometer, a peak-to-peak noise power fluctuation of the equipment corresponded to temperature changes of about one degree K for a response time of 4 sec. This compares with about 5 degrees K for a superheterodyne radiometer having the same noise figure and response time. When the gain stabilization feature (signal chopper and synchronous detector) are deactivated, long-term drift becomes severe, but the system maintains its short-term sensitivity.

Results of the refraction experiments indicate that average refraction is the same in the microwave region as in the optical region. However, results indicate that during a particular day, there might be considerable fluctuation about this average.

Amplitude scintillations detected with the antenna at a low angle are always present and can be of large amplitude with longer periods prevailing. At higher angles, the fluctuations are probably solar in origin and are of short period and small amplitude. While the origin of the scintillations is probably meteorological, no correlation of scintillation amplitude at low angles and commonly measured meteorological parameters was noted.

The absorption measurements yield a value of 0.00348 db/km.

This material was abstracted from "Absorption, Refraction and Scintillation Measurements at 4,700 Mc with a Traveling-Wave Tube Radiometer" by John P. Castelli, Jules Aarons, Carl Perioli and Joseph Casey of the Air Force Cambridge Research Center.

Point-to-Point Communications

Extremely narrow sky path minimizes possibility of interception of new communications gear. Raytheon produced system being operated by Marine Corps unit has 40-mile effective range

Auto Tachometer Uses Transistor

By JAMES COWAN
Radson Engineering Corp., Macon, Ill.

DESIGN of an accurate electronic tachometer for automobiles involves several factors. Primary considerations include final size, ease of installation and, since the field is quite competitive, retail price.

In the transistorized tachometer described here, the vehicle battery was to be used, rather than a separate source of power. This created a problem, in that voltage in automobile electrical systems varies as much as ±3 volts, because of motor speed and voltage-regulator setting.

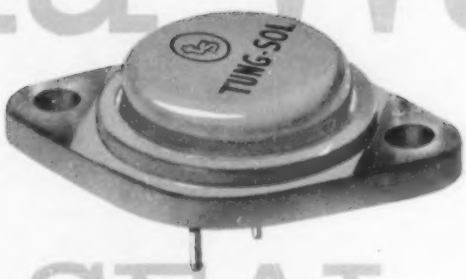
A constant supply voltage was obtained in the tachometer shown in Fig. 1 by using a zener diode, D_1, from the transistor collector to ground. This is an inexpensive yet effective way of eliminating an internal voltage source, such as is used in several other types of automobile tachometers.

The ignition waveform is used as a means of triggering the circuit. This waveform is rectified by diode

TUNG-SOL POWER TRANSISTORS IMPROVED THREE WAYS BY:

NEW

Cold-Weld



SEAL

Tung-Sol's new true cold-weld seal represents a major advance in transistor technology. An exclusive Tung-Sol development, cold-weld sealing increases TO-3 outline package efficiency and brings designers a threefold bonus in over-all transistor performance.

Improved thermal qualities. The cold-weld process produces a hermetic, copper-to-copper seal and makes possible a 100% copper transistor with thermal properties superior to previous high power types.

Improved reliability. Cold-weld encapsulation eliminates heat damage, "splash", and heat-caused moisture that can impair transistor performance.

Longer efficient life. Even through temperature fluctuations that cause "breathing", the cold-weld seal stays vacuum-tight, moisture-proof—result of actual integration of the copper molecules during sealing.

Tung-Sol power switches with the new cold-weld seal withstand the most rigid combination of tests given any transistor—the 100 psi "bomb" immersion test and the critically sensitive Mass Spectrometer leak test. Further, they meet all military environmental requirements. For full data on the improved Tung-Sol types . . . to fill any transistor need, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

THESE TUNG-SOL HIGH POWER (TO-3 OUTLINE) TRANSISTORS FEATURE THE NEW, COLD-WELD SEAL

Type	BVCES (V_{BE} = +1.0v) Volts (Min)	BVCEO (I_B = 0) Volts (Min)	hFE (I_C = 1.0 A)	hFE (I_C = 2.0 A)
2N378	−40	−20	50	30
2N379	−80	−40	50	30
2N380	−60	−30	70	50
2N459	−105	−60	50	30

TO-3

IMPROVED SPECIFICATIONS OF TUNG-SOL COLD-WELDED HIGH POWER TRANSISTORS.

Collector Dissipation @ 25°C*...50 Watts
Collector Dissipation @ 55°C*...25 Watts
Thermal Resistance.....1.2° C/Watt Max.
I_{CBO} @ V_{CB} = −25v T = 25°C...0.5 Ma Max.
I_{CBO} @ V_{CB} = −25v T = 85°C...7.5 Ma Max.
Storage Temperature.....−55 to +100°C

*Mounting base temperature

TUNG-SOL®

D_2 and applied to the base of transistor Q_1.

The waveform produced by automobiles made by different manufacturers varies because of differences in point and spark-plug gap setting. Rapid acceleration also alters the waveform. Because of these differences and the large number of transients in these waveforms, resistors R_1 and R_2 and capacitor C_1 are used in the transistor base circuit to filter the waveform.

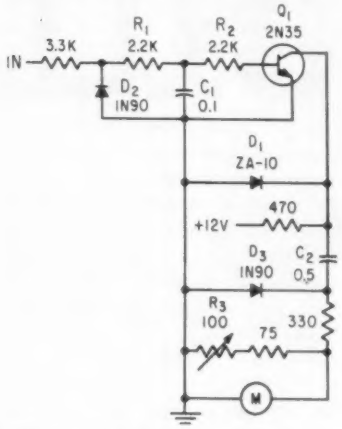
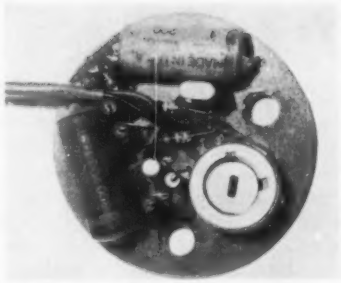


FIG. 1—Simple tachometer circuit uses zener diode to compensate variations in vehicle 12-volt system



Compact printed-circuit package makes single-unit auto tachometer possible

The positive pulse triggers transistor Q_1, charging capacitor C_2 through the meter. Pulse repetition rate determines the amount of current through the meter. Capacitor C_2 discharges through diode D_3.

The meter is calibrated in revolutions per minute, and final adjustment is made by resistor R_3. The meter covers the range from zero to 6,000 rpm.

The entire tachometer is housed in a single unit. A printed circuit is used to save space and to speed assembly.

Only two electrical connections are required to install the tachometer, which has been designed for 8-cylinder automobiles having 12-volt ignition systems.

Shot Counter Uses Strobotron

By **RONALD L. IVES** Palo Alto, Calif.

DURING TESTING of some new ballistic equipment, need arose for a portable, self-contained, self-powered shot and blast counter. The unit was required to be roughly directional, sensitive only to loud noises and made only of standard, easily obtained parts. A low-cost sensor was also desirable, because of the probability of destruction during tests.

These objectives were attained by using a cheap p-m speaker as a pickup, a single stage of amplification using a 1U4, a 1D21 strobotron counter actuator and an electromagnetic counter. The circuit is shown in Fig. 1.

Tests show that the cone of admittance of the p-m speaker has an included angle of about 60 degrees, with sensitivity falling off rapidly outside this zone.

Pulses produced when a shock wave hits the speaker are stepped up in voltage by a small line-to-grid transformer. In the secondary circuit, positive pulses are dumped by a germanium diode, and negative pulses go to the grid of the 1U4 amplifier. Although the circuit will work with either speaker polarity, best operation is secured if the first shock wave produces a negative pulse on the 1U4 grid.

The plate of the 1U4 is connected to the inner grid of the strobotron directly and the B+ through a high resistance, producing the well-known draw-down circuit. When input is quiescent, the grid of the 1U4 is approximately at ground potential; the plate of this tube and the grid of the strobotron are at a very low potential (about 10 volts). Therefore, the strobotron does not fire.

When a shock wave impinges on the sensor, the grid of the 1U4 is driven negative, cutting the tube off, and plate potential rises to approximately 135 volts. The control grid of the strobotron, which is directly connected to the 1U4 plate, also rises toward 135 volts, firing the tube.

The plate circuit of the strobotron is the familiar dumper circuit, apparently first described by Germeshausen and Edgerton (see ELECTRONICS, Feb. 1937, p 12). Here, the firing of the tube dumps the charge on the 2-microfarad capacitor from plate to ground, and because of the high series impedance (counter plus resistor), starves itself out. Recharge of the capacitor, after tube extinction, operates the electromechanical counter.

Sensitivity of the circuit to speaker vibrations and reverberations is reduced by a small capacitor shunted from the plate of the strobotron to the screen of the 1U4. This capacitor, when the strobotron fires, draws down the screen voltage of the 1U4 momentarily, desensitizing the input amplifier. Exact value of this capacitor depends upon the properties of the speaker used as a sensor. This capacitor also lowers the frequency of operation of the system appreciably.

With no plate-screen feedback, dependable operation can be expected at rates up to 40/sec, sufficient for most automatic weapons fire. With a 0.1-microfarad capacitor, maximum operating frequency is reduced to about 5/sec.

A twisted pair is suitable for connecting the sensor to the circuit at distances less than 10 ft. From 10 to 250 ft, however, a shielded pair should be used.

When the equipment is energized,

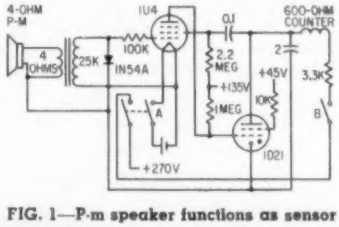


FIG. 1—P-m speaker functions as sensor in self-contained shot and blast counter

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GVB, for Guaranteed Voltage Breakdown (limits), is what we call this new finish. It is perfectly matched to our aluminum core boxes, for it will withstand temperatures from −70°F to 450°F. Potting techniques need not change, for GVB-finish lives happily with standard potting compounds.

By eliminating the need for taping the core box, you also eliminate a time consuming production step. By combining GVB-finish with our aluminum core box, we assure you a core capable of being vacuum impregnated down to 20 mm. of mercury.

And they are Performance-Guaranteed! Like all tape wound cores from Magnetics, Inc., aluminum-boxed or phenolic-boxed, you buy them with performance guaranteed to published limits. The maximum and minimum limits are for B_m, B_r/B_m, H_i and gain. This data is published for one, two, four and six mil Orthonol® and Hy Mu 80 tape cores.

GVB-finished cores are ready for you now. So are the published limits for all Magnetics, Inc. tape wound cores. Write today for more GVB details, and for your copy of the guaranteed performance limits: Dept. E-51, Magnetics, Inc., Butler, Pennsylvania.

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CIRCLE 62 READERS SERVICE CARD

NEW

electronically controlled

TOROIDAL WINDER

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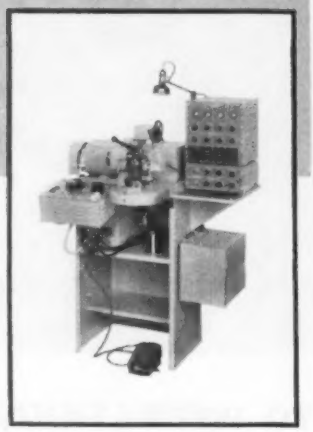
speeds up to 2000 turns per minute
4-digit, 2- or 7-position predetermined turns counting



The entirely NEW electronic system of the TW 300 provides unmatched features in a toroidal winder . . . proximity pick-up for use with any size wire without physical contact . . . 100% accurate turns counting . . . controlled slow-start, slow-stop driving motor . . . automatic segmental winding with perfect repeatability . . . progressive winding of segments or continuous coils in either direction.

The TW 300, designed for easy servicing and maintenance, cuts production time and operator fatigue to the bone. Flexibility in production of new coil types with superior electrical characteristics is unlimited because of the new control system with automatic winding features. This machine is a significant advance toward complete automation of toroidal winding.

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switch A should be closed before switch B.

With rather obvious alternative or additional circuitry, this shot counter can be used to control a clock or chemical sampler in response to a blast. It might even be used to operate a robot sentry, which fires a short burst from a machine gun whenever other weapons are fired toward it, within the acceptance cone of the sensor, and not more than about 250 ft distant.

Addition of a second stage of amplification is, of course, entirely possible. This makes the instrument responsive to the passage of aircraft overhead, to noisy automobile engines and even to children on roller skates.

Semiconductors Provide Analog Voltage Source

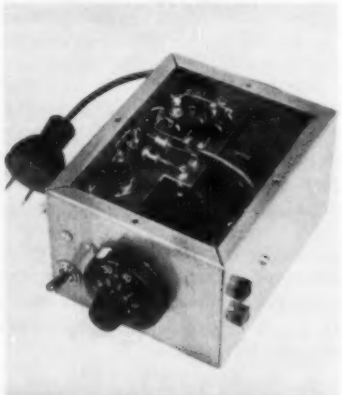
By **E. R. JAMES** Design Engineer, Motorola, Inc., Riverside, Calif.

VARIABLE power supplies are one of the most frequently used pieces of laboratory equipment.

Although many power supplies are available on the market, their size and cost often limit their applications. Some lack precision control of the voltage output. Batteries also have disadvantages such as poor regulation and short life.

The power supply described overcomes many of the disadvantages of commercial supplies and batteries. It is compact, has low drift and ripple, is easily calibrated.

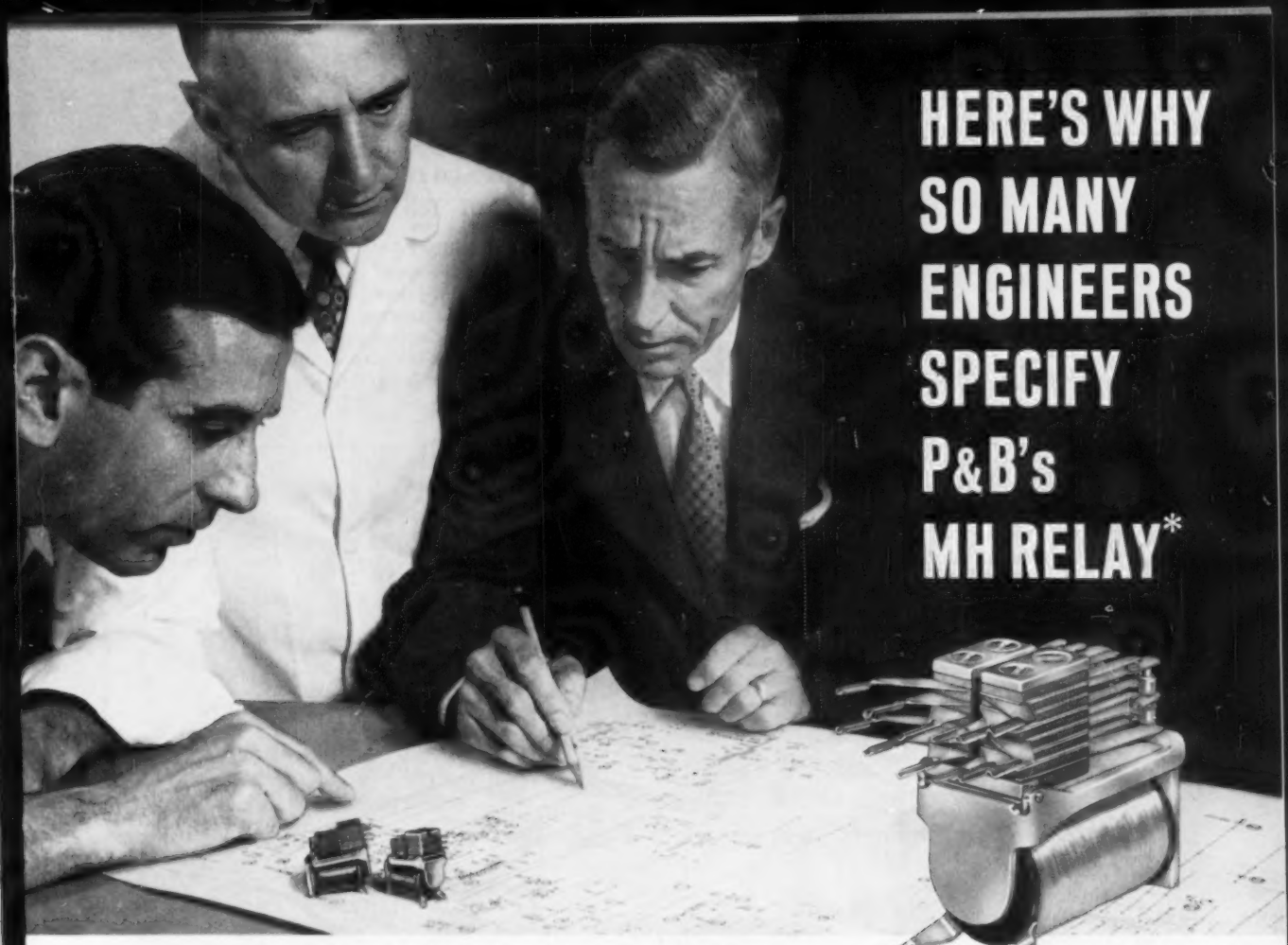
Although this supply was de-



(A) Compact packaging adds to usefulness of versatile voltage source

CIRCLE 64 READERS SERVICE CARD

CIRCLE 65 READERS SERVICE CARD →



HERE'S WHY SO MANY ENGINEERS SPECIFY P&B's MH RELAY*

*AND VARIATIONS OF THIS BASIC STRUCTURE SHOWN BELOW

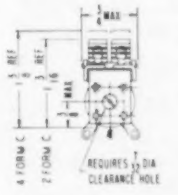
Shown with printed circuit terminals

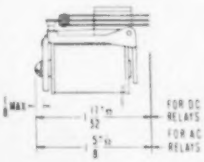
VERSATILITY

and adaptability are prime reasons why designers have made the MH a P&B best seller. This relay series, for example, does yeoman duty in such diverse applications as jet aircraft, street lighting equipment, computers and missile ground controls.

When multiple switching is required... when size, weight, long life and reliability are critical ...our MH relay can usually fill the bill. It's RIGHT for countless jobs, often at countable savings.

Let us send you complete information about this miniature telephone-type relay and the variations we've evolved for special applications. Write or call today.





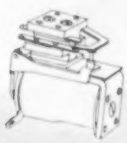
ENGINEERING DATA/MH RELAY

Insulation: Laminated phenolic.
Insulation Resistance: 100 megohms minimum.
Breakdown Voltage: 500 volts RMS between all elements.
Shock: Up to 30g.
Vibration: Up to 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps.
Ambient Temperature: −45°C. to +85°C. −(65°C. to +125°C. on special order).
Weight: 2½ oz. max. (open relay)
Pull-In: Approx. 75% of nominal voltage.
Pull-In Speed: Approx. 15 ms.
Drop-Out Speed: Approx. 10 ms.
Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:
Arrangements: Up to 9 springs per stack.
Material: ⅛" silver; also Palladium or gold alloy.
Load: Dry circuits to 5 amps @115V AC resistive.

COILS:
Resistance: 22,000 ohms max.
Power: 100 milliwatts per movable minimum to 4 watts at 25°C. max. (200 mw. min. to meet max. shock/vibration spec.)
Duty: DC: Continuous. AC: Intermittent (2 pole relay max.)
Voltages: DC: Up to 110 volts. AC: Up to 230 v. 60 cycles.
Current: 2.5 ma to 10 amps DC.

P&B STANDARD RELAYS AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



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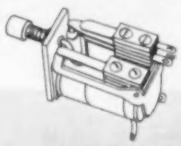

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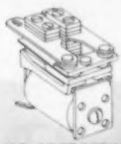
Electrical latch; mechanical reset. Small, versatile and offered with selection of contact arrangements.



MB CONTACTOR
Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.

MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

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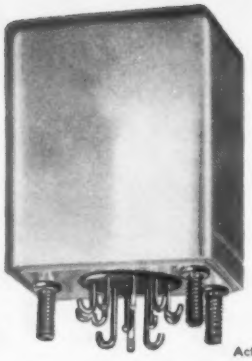
NEW RBM

BHSM and BHSM HT TYPES



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Miniature Hermetically Sealed Relays

The reliability of this relay under severe conditions of vibration and shock has been field-proven in many applications. It is another example of how R-B-M's production maturity and complete facilities can eliminate many of your engineering problems.

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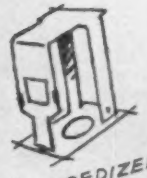

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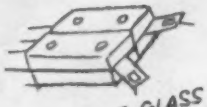

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OPERATING BENEFITS

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- CONTACTS–MAX. 4 PDT 3 AMP. AT 32 V.D.C. OR 115 V.A.C. (NON-INDUCTIVE)
- SPECIAL CONTACTS AVAILABLE FOR LOW LEVEL OR DRY CIRCUIT APPLICATIONS
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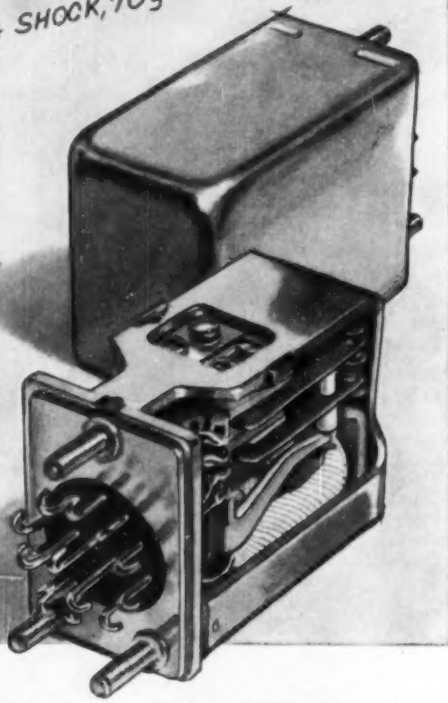
- 30g OPERATING SHOCK, 70g NON-DESTRUCTIVE



Consult your local RBM Product Application Engineer or write for Bulletin BHSM-1.

RBM Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

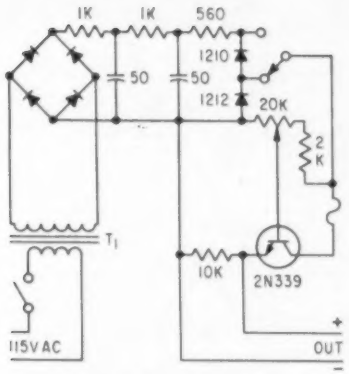


FIG. 1—Silicon transistor in precision voltage source isolates control potentiometer from output current

signed as an analog voltage source for computer circuits, it may be used in many other applications. In addition, modifications requiring less costly parts are possible where performance is not so critical.

Circuit Description

The circuit may be considered in two discrete parts—voltage supply and control element. The complete circuit is shown in Fig. 1. The voltage supply is a bridge rectifier with r-c filtering that reduces ripple sufficiently for a low-voltage, low-current device. Zener diodes provide good regulation.

The control unit uses a transistor in the grounded-collector configuration. This arrangement serves a twofold purpose. It improves linearity of the control potentiometer by lessening loading effects, and it isolates the output current from the precision potentiometer. The latter feature protects the potentiometer from accidental burnout from excess current drain.

Output impedance of the emitter follower for the voltage range considered is

$$r_o \approx r_e + \frac{R_g + r_b}{1 - \alpha_{cb}}$$

In the present application r_b is about 30 ohms, which makes $R_g >> r_b$. Therefore, the above expression can be simplified to

$$r_o \approx r_e + R_g (1 - \alpha_{cb})$$

Before evaluating this expression, it is necessary to determine r_e as a function of voltage out.

$$r_e = \frac{d V_{bo}}{d I_e} \approx \frac{k T/q}{I_e} = \frac{0.026}{I_e}$$

Since α_{cb} is 0.96 for the transistor used in the circuit, output impedance expressed in measurable quantities is

$$r_o = \frac{260}{V_{out}} + 0.04 R_g$$

A plot of this expression is shown in Fig. 2.

From the graph (Fig. 2), it can be seen that the impedance varies from 400 to 800 ohms in the 10-volt setting and from about 200 to 800 ohms in the 20-volt setting. However, restricting the use of the 20-volt setting for voltages from 10 to 20 volts, the impedance of the source can be considered as 600 ohms nominally.

Accurate calibration is provided by a ten-turn 0.1-percent potentiometer with a ten-turn dial. A calibration curve is shown in Fig. 3. After four hours, a similar curve was within 0.2 percent of the original calibration. A drift curve is shown in Fig. 4. After one hour, the drift rate is 5 millivolts per hour. Ripple is less than 5 mv.

Circuit Variations

The voltage source discussed was designed to meet a special need—that of a highly accurate, stable source. Because of this, a silicon transistor and two zener diodes were used to maintain stability over a wide voltage range. If maximum stability were not the major factor, a considerable reduction in cost could be effected by using a

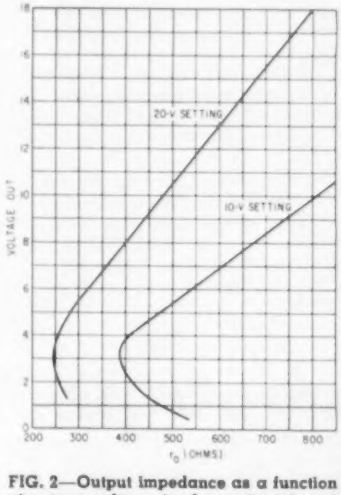


FIG. 2—Output impedance as a function of output voltage is shown for 10 and 20-volt settings

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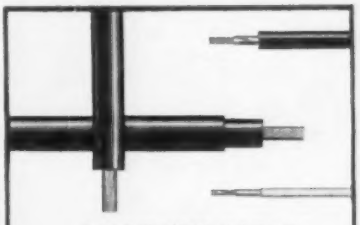

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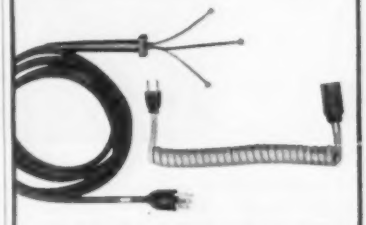

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The machine above is a unique testing instrument, designed by Audio Devices engineers and installed at the Audiotape plant in Glenbrook, Conn. This Automatic Defect Counter records and plays back every inch of the EP Audiotape under test.

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This is one of many special quality-control operations to which type EP Audiotape is subjected. The extra attention begins at the raw material stage where the master rolls of base materials are critically examined for uniformity of gauge, freedom from stretch, and cleanliness. The oxide and binder components are selected for fineness of dispersion and magnetic properties—then combined and fed through a micronic filter and metered on the selected foil in Audio's special dust-free precision coating machines. The coated master rolls are then selected for freedom from imperfections and proceed through the slitting operation. Each ribbon is wiped after slitting to remove all traces of dust, run through the defect counter, rejects discarded, and the defect-free tape packed in hermetically sealed metal cans or plastic cases.

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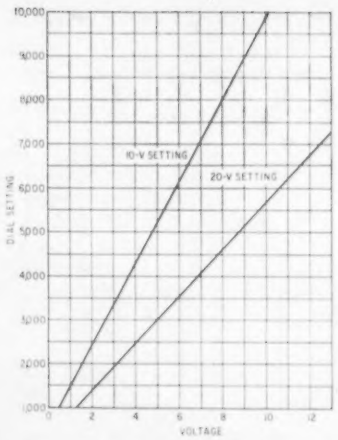


FIG. 3—Plot shows output voltages for potentiometer settings on both voltage ranges

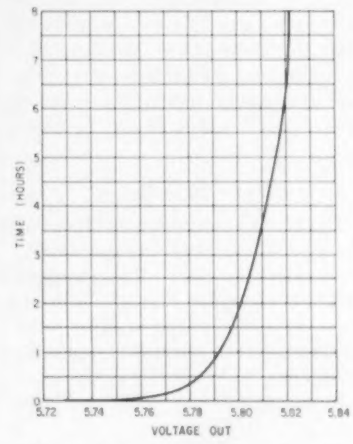
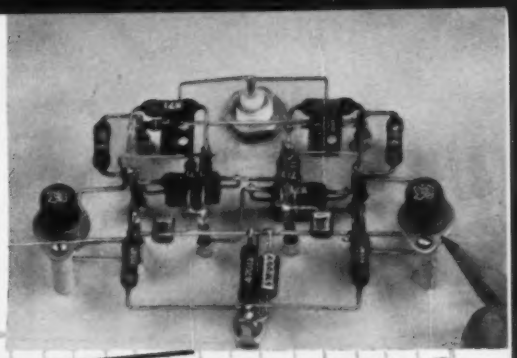


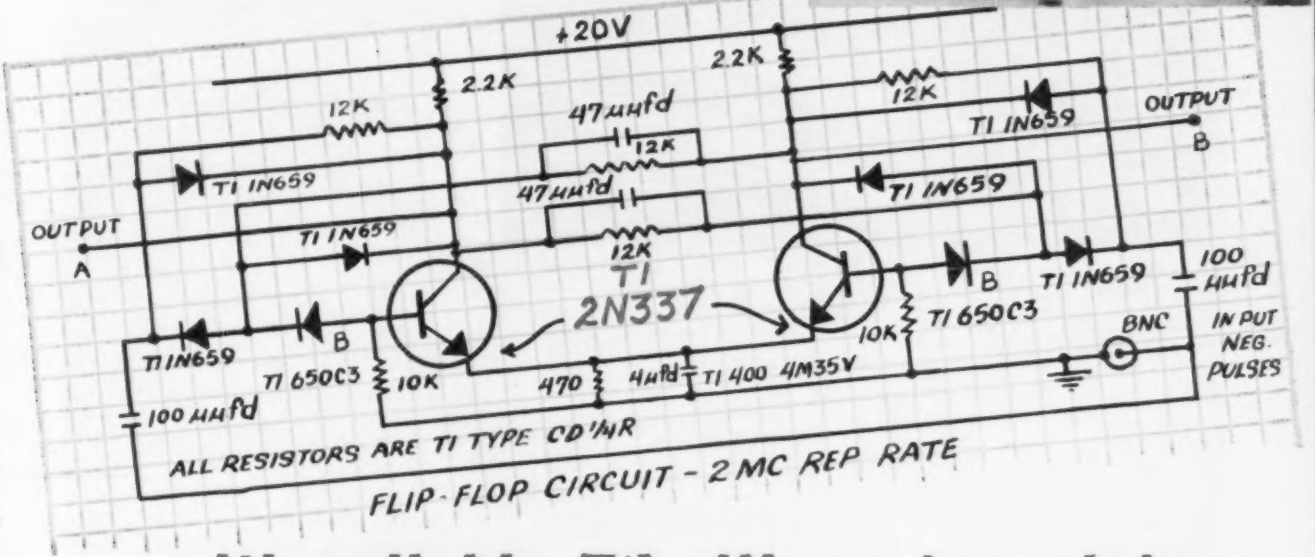
FIG. 4—Drift rate was 5 mv/hr after one hour

simple zener diode (eliminating the switching circuit) and a germanium transistor. The transistor must have a power dissipation sufficiently great to handle the load current at maximum voltage.

Another variation is possible that would materially reduce cost. This is a variable voltage supply with specified current rating. In this application, the ten-turn potentiometer may be replaced by a standard 2-watt potentiometer. The transistor could be a low-cost power transistor. For currents in excess of 20 ma, the resistor in series with the zener diode will have to be chosen so that at maximum current drain, there would be sufficient current through the zener to keep it in its regulatory region. Chokes in the filter circuit would be adjustable at higher currents to decrease d-c resistance.

HIGH SPEED SWITCHING





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NEW IMPROVED SPECIFICATIONS FOR 2N337 AND 2N338

	from	to
BV_{CBO}	40 V max	45 V max
R_{CS}	300 Ω max	150 Ω max
h_{ib}	90 Ω max	80 Ω max

Consider TI's guaranteed specifications when you select semiconductor devices for your next transistor circuit.

design characteristics at 25° C ambient (except where advanced temperatures are indicated)

		test conditions		2N337 min	2N337 design center	2N337 max	2N338 min	2N338 design center	2N338 max	unit
I_{CBO}	Collector Cutoff Current	V_{CB} = 20V	I_E = 0	—	—	1	—	—	1	μA
	at 150°C	V_{CB} = 20V	I_E = 0	—	—	100	—	—	100	μA
BV_{CBO}	Breakdown Voltage	I_{CB} = 50μA	I_E = 0	45	—	—	45	—	—	V
BV_{EBO}	Breakdown Voltage	I_{EB} = 50μA	I_C = 0	1	—	—	1	—	—	V
h_{ib}	Input Impedance	V_{CB} = 20V	I_E = −1mA	30	50	80	30	50	80	Ohm
h_{ob}	Output Admittance	V_{CB} = 20V	I_E = −1mA	—	0.2	1	—	0.2	1	μmho
h_{rb}	Feedback Voltage Ratio	V_{CB} = 20V	I_E = −1mA	—	200	2000	—	300	2000	X10⁻⁶
h_{fb}	Current Transfer Ratio	V_{CB} = 20V	I_E = −1mA	0.95	0.985	—	0.975	0.99	—	—
h_{FE}	DC Beta	V_{CE} = 5V	I_C = 10mA	20	35	55	45	80	150	—
$f_{\alpha b}$	Frequency Cutoff	V_{CB} = 20V	I_E = −1mA	10	20	—	20	30	—	mc
C_{ob}	Collector Capacitance*	V_{CB} = 20V	I_E = −1mA	—	1.2	3	—	1.2	3	μμf
R_{cs}	Saturation Resistance†	I_B ‡	I_C = 10mA	—	75	150	—	75	150	Ohm
h_{fe}	Current Transfer Ratio	V_{CB} = 20V	I_E = −1mA, f = 2.5mc	14	22	—	20	24	—	db
t_r	Rise time§			—	0.05	—	—	0.06	—	μsec
t_s	Storage Time			—	0.02	—	—	0.02	—	μsec
t_f	Fall time			—	0.08	—	—	0.14	—	μsec

* Measured at 1 mc † Common Emitter ‡ I_B = 1mA for 2N337, 0.5mA for 2N338 § Includes delay time (t_d)

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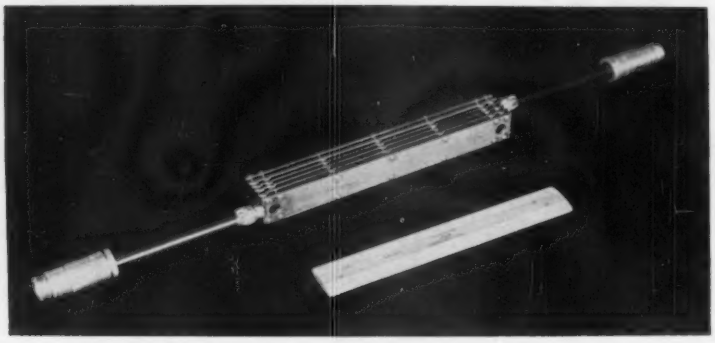


Small physical size of phase shifter is evident here

FERRITE DEVICES capable of 360-deg phase shift in the uhf region are sometimes too lossy and bulky to be practical. But a unit developed by Electronic Communications, Inc., Timonium, Md., is only 6½-in. long and less than one in. square in cross-section. The 360-deg phase shift is accomplished with about one db of loss.

Basic to the design of the shifter is a folded Stripline structure as shown in Fig. 1. Each of five layers of Stripline is loaded with two 0.40 by 0.05 by 6 in. strips of TT-414 ferrite (Trans-Tech, Inc.), one on each side of the center conductor. The ferrite is a magnesium-manganese-aluminum combination with a saturation magnetization of 600 oersteds and a Curie temperature of about 100 C. To provide continuity between layers, the center conductor is folded. Total length of ferrite through which the wave must travel is 32.2 in.

The phase shifter requires a longitudinal magnetic field of enough intensity to place the operating region above resonance. For the unit fabricated, this is supplied by a 12-in. long, 1¼-in. diam solenoid into which the phase shifter fits easily.

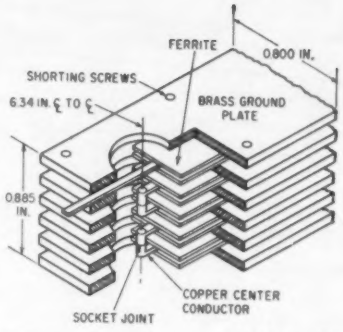


FIG. 1—Cross-section of folded uhf phase shifter

Operating Characteristics

Original range of interest for the unit was 200 to 600 mc but characteristics were actually investigated from two to 2,000 mc. Figure 2 shows results obtained at 200, 400, 600 and 800 mc. Table I gives pertinent characteristics at each of these four different frequencies.

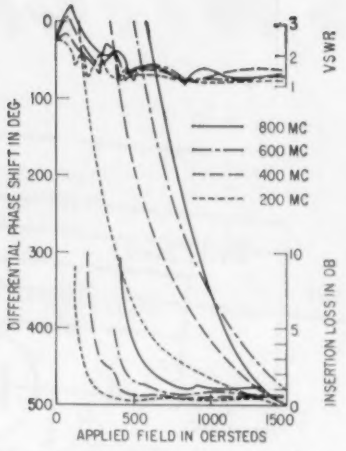


FIG. 2—Phase-shifter characteristics at 200, 400, 600 and 800 mc

The phase shifter is a reciprocal device and can be used in both transmitting and receiving systems.

Table I—Phase-Shifter Characteristics at Different Frequencies

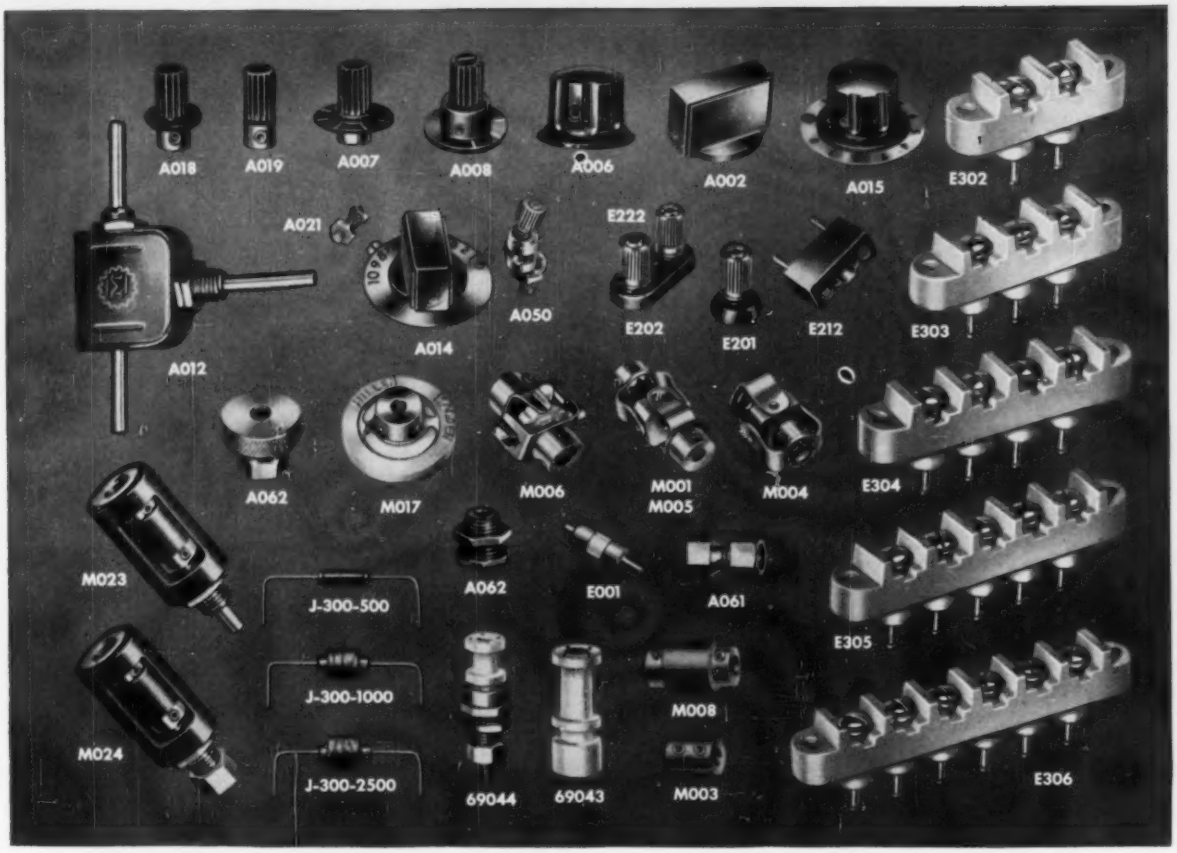
Frequency in mc	Insertion loss in db	Differential phase shift in deg	Magnetic-field change in oersteds	Max vswr over field range
200	1.6	360	220–1,500	1.8
400	1	360	430–1,250	1.45
600	1.1	360	625–1,625	1.5
800	1.4	360	730–1,630	1.5

Miniature Motor Has Simple Stator

A BOBBIN-WOUND COIL and a simplified stator designed by Dynamic Instrument, Westbury, N. Y. permit servo motor sizes as small as 0.3 in. diameter. Simplicity of the coil and stator construction should give a production cost less than half that of ordinary motors.

The small size is possible because of the low magnetizing power needed to produce a suitable electromagnetic field. Regardless of how many poles there are in the motor, and disregarding stray leakage flux, all of the magnetic field lines per phase link all of the turns per phase.

The motor reaches full speed of 1,460 rpm in 0.004 sec and can be provided with a variety of shaft extensions, power and voltage ratings. It can be wound for class-H (to 400 F ambients), for transistor operation, as well as other varieties to suit special customer needs. Push-pull and high voltage types (used for direct coupling to a driver



MINIATURIZED COMPONENTS

DESIGNED for APPLICATION miniaturized components developed for use in our own equipment such as the 90901 Oscilloscope, are now available for separate sale. Many of these parts are similar, in most details except size, to their equivalents in our standard component parts group. In certain devices where complete miniaturization is not paramount, a combination of standard and miniature components may possibly be used to advantage. For convenience, we have also listed on this page the extremely small sized coil forms from our standard catalog.

CODE	DESCRIPTION
A001	Bar knob for ⅛" shaft. ½" high by ¾" long.
A006	Fluted black plastic knob with brass insert for ⅛" shaft. ½" high by ¾" diameter.
A007	¼" black plastic dial knob with brass insert for ⅛" shaft. ⅝" diameter dial. ⅝" high.
A008	¼" black plastic knob. Same as no. A007 except for style.
A012	Right angle drive for ⅛" shafts. Single hole mounting.
A014	1" bar dial for ⅛" shaft. ½" high. 180° or 280° dials for clockwise or counter-clockwise rotation.
A015	1" fluted knob dial for ⅛" shaft. ½" high. Same dial plates as no. A014.
A017	1⅛" diameter fluted black plastic knob for ⅛" shaft.
A018	Knob, same as no. A007 except with ⅜" diameter skirt.
A019	Knob, same as no. A007, but without dial.
A021	Miniature metal index for miniature dials.
A050	Miniature dial lock.
A061	Shaft lock for ⅛" diameter shaft. ¼"-32 bushing. Nickle plated brass.
A062	Shaft lock with knurled locking nut.

CODE	DESCRIPTION
A066	Shaft bearing for ⅛" diameter shafts. Nickle plated brass. Fits 17/64" diameter hole.
E001	Steatite ceramic standoff or tie-point. Integral mounting eyelet. 0.205" overall diameter.
E201	Black or red plastic binding post plates for No. E222.
E202	Black or red plastic plates for two binding posts spaced ½".
E212	Black or red plastic plug for two binding posts spaced ½".
E222	Metal binding post with jack top.
E302A	to E306A Steatite ceramic terminal strips. ⅜" wide. Terminals spaced ⅜" on centers. Screw type or solder type thru-terminals.
J300–350	to J300–2500 Complete line of miniature inductances 3.3 to 2500 microhenries. ⅜" long. Diameter 0.115" to 0.297".
M001	Insulated universal joint style flexible coupling for ⅛" dia shafts.
M003	Solid coupling for ⅛" dia. shafts. Nickle plated brass.
M004	Universal joint style flexible coupling for ⅛" diameter shafts. Inverted hubs for short length. Not insulated.
M005	Universal joint style flexible coupling for ⅛" diameter shafts. External hub for maximum flexibility. Not insulated.
M006	Universal joint style flexible coupling for ⅛" diameter shafts. Spring finger. Steatite ceramic insulation.
M008	Plastic insulated coupling with nickle plated brass inserts for ⅛" diameter shafts.
M017	Plastic insulated flexible coupling for ⅛" diameter shafts. 17/32" long by 13/16" diameter. Bronze yoke.
M023	Insulated shaft extension for ¼"-32 bushing and ⅛" shaft. For mounting sub-miniature potentiometer.
M024	Locking insulated shaft extension similar to no. M023.
69043	Steatite ceramic coil form. Adjustable core. Winding space ¼" diameter by 13/32" long. Mounting 4-40 hole.
69044	Steatite ceramic coil form. Adjustable core. Winding space 0.187" diameter by 3/16" long. No. 10-32 mounting.

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amplifier, eliminating the need for an output transformer) are also available to impedance ratings impossible in more conventional type units. Ratings of 115 v in diameters down to a fraction of an inch eliminate the step-down transformers and large capacitors usually found in low voltage miniature motors. For example, a 26 v motor employing a 2-μf tuning capacitor would require only 0.1-μf capacitor at 115 v. Where required, dielectric strengths of 2,000 v can be provided. Dielectric strengths of 1,250 v between phases and to the frames are standard, even in very small frame sizes, where previously they could be achieved only with difficulty and often with a large percentage of rejections in production.

Special Tube Fins Offset Calefaction

By **C. BEURTHERET,** Compagnie Francaise Thomson-Houston, Paris, France and **H. G. TOWLSON,** General Electric Co., Syracuse, N. Y.

CURRENTLY UNDER STUDY by the FCC is the advisability of allowing certain so-called clear-channel a-m stations to exceed the 50-kw broadcast power limit. New powers proposed are 500 kw minimum and 750 kw maximum. With higher powers, tube cooling will be more of a problem. One technique first reported in ELECTRONICS[1] makes use of novel fin design to take advantage of fundamental heat-transfer principles.

Figure 1 shows the relation between heat flow per unit area and temperature of a small metallic surface immersed in still water. Zones *C* and *D* are known as the calefaction region. In a household analogy, calefaction is illustrated by a drop of water on a hot stove where the steam prevents effective heat transfer of the liquid.

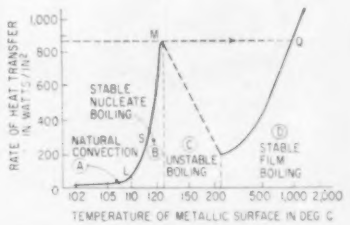
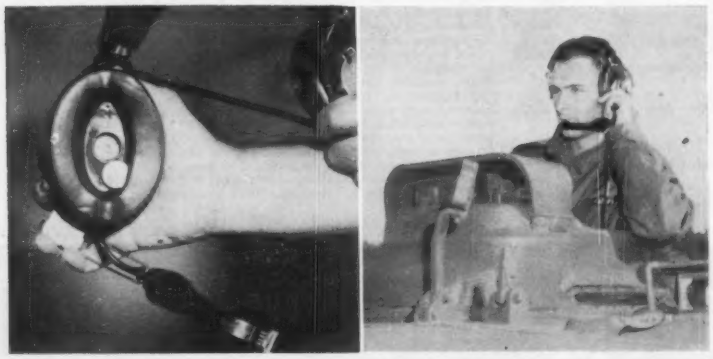


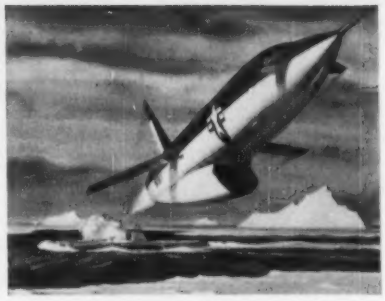
FIG. 1—Boiling heat-transfer curve for small metallic surface in still water. Zones *A, B, C* and *D* correspond to different physical phenomena as indicated. Region beyond Q is where melting point of copper is exceeded

With a larger area, such as the cylindrical anode of a conventional water-cooled tube, steam produces an insulating layer which reduces contact of the anode with the water. The anode's melting point can then

To Eliminate Noise—Add Some



Electronic earphone contains miniature microphone which generates noise signals opposite in phase to loud unwanted noises. When two sound waves meet in earcup, most of total noise energy is dissipated. Developed by U. S. Army Signal Research and Development Lab, Ft. Monmouth together with RCA, the earphone works with a special electronic inverter and amplifier unit



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in′ge·nu′i·ty: *designing a 12-ton missile to fit inside an atomic sub*

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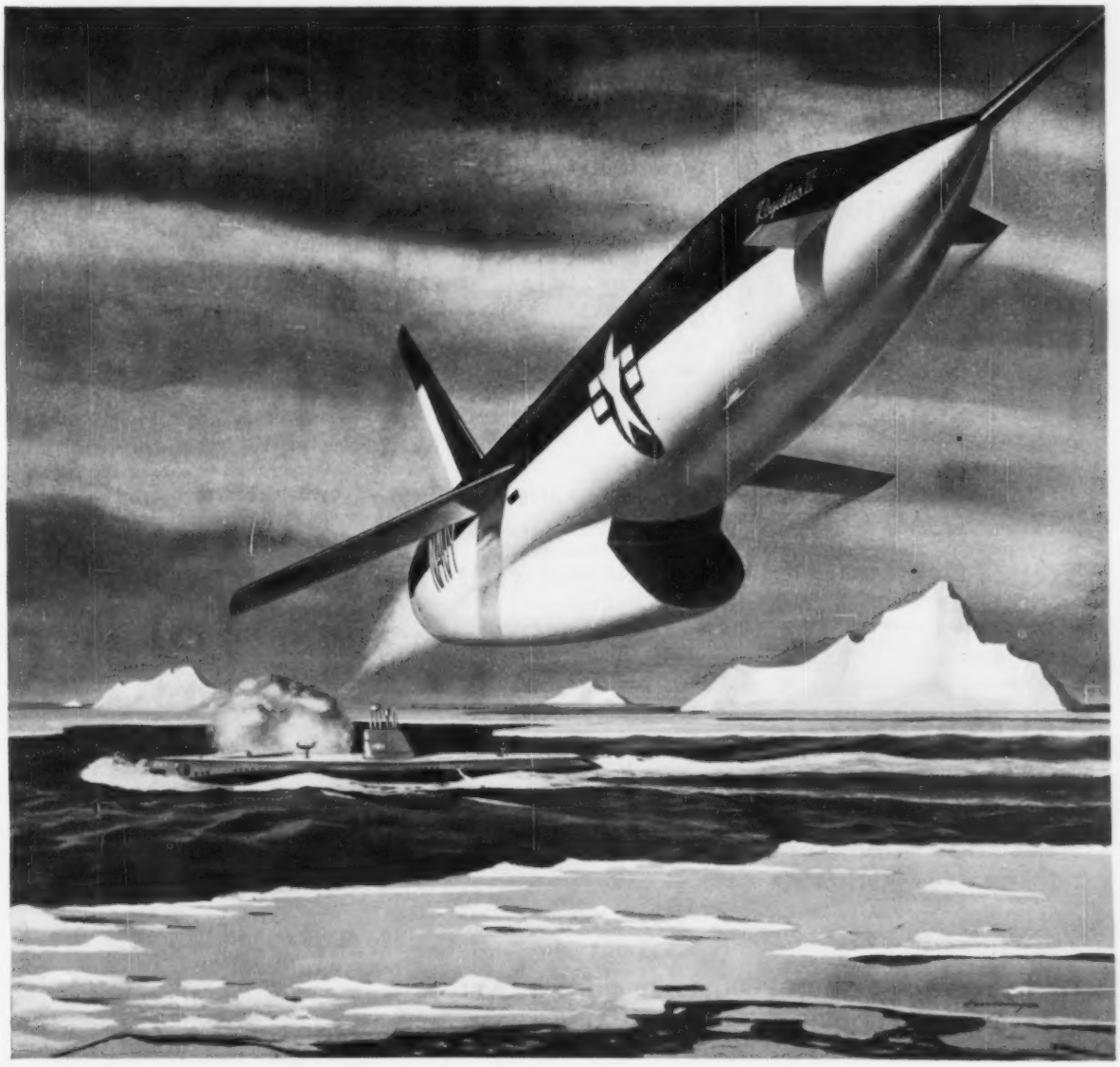
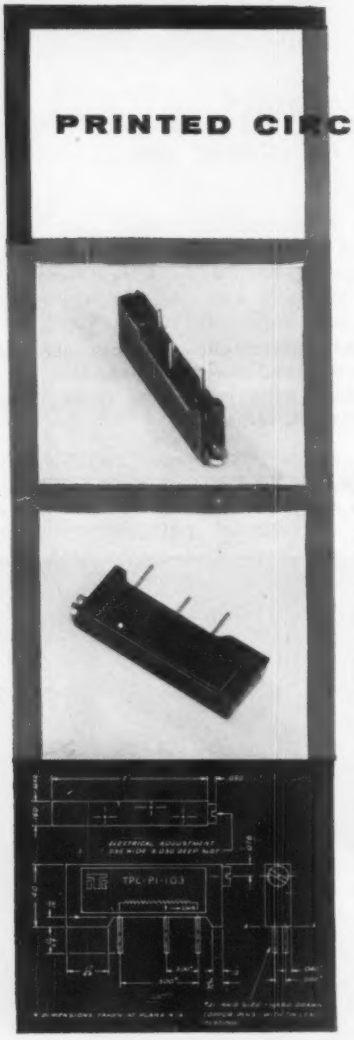


PRINTED CIRCUIT TRIMMERS

BY TIC



Type TPC Printed Circuit Trimmer Shown Actual Size

This new subminiature trimmer is designed for printed circuit assembly.

SLIM *and* **TRIM,** *they fit neatly with diodes and transistors.*

Constructed of high-temperature-resistant plastic, with a 37 turn lead-screw adjustment for fine trimming, the TPC trimmer is a masterpiece of miniaturization. Virtually hermetic sealed, this newest addition to the TIC line is moisture proof. Power rating is 1 watt at 70°C. derated to 0 at 225°C. Pretinned leads accommodate hot-tin dipping techniques. Lead separations are in multiples of 0.1" in accordance with standard printed circuit separations.

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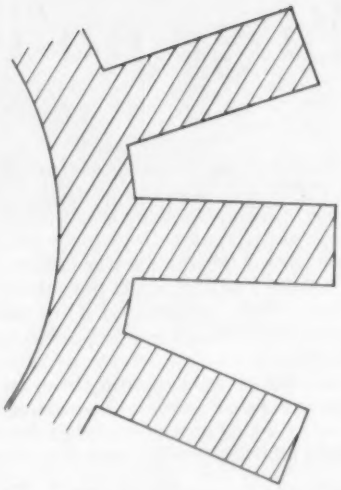

FIG. 2—Teeth of power tube are designed as shown

be at point *S*, Fig. 1, or about 200 w/in.^{2}.

By designing the teeth or fins of the power tube as shown in Fig. 2, permanent contact with the liquid by the tips of the fins is insured and temperature can be kept below 110 C (point *L*, Fig. 1). With teeth of good thermal conductivity it is physically impossible for two adjacent points of the surface to be at 125 C (Point *M*, Fig. 1) and 1,100 C (point *Q*).

Figure 3 is a sketch of a Vapotron with vertical fins. Tubes have also been made with horizontal fins. A third version uses a tooth-type construction combining vertical and horizontal fin concepts.

In operation, the tube is set in a

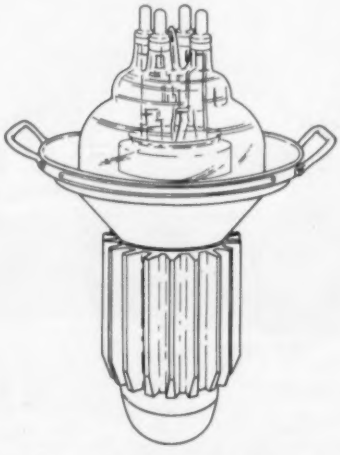

FIG. 3—Vertical-fin version of tube has this physical appearance

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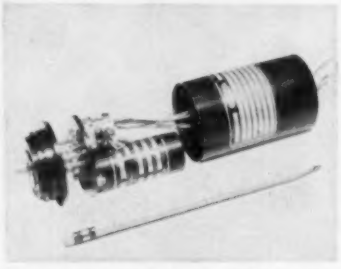
tank. Steam rises through a short insulating pipe to a condenser and returns as water to a storage tank. No water pump is required.

The technique described has been proved in more than a million hours of operation.

REFERENCE

(1) C. Beurtheret, Evaporation-Cooled Power Tubes, ELECTRONICS, 25, p 106, Mar. 1952.

Turret Mounting Servo Components



Servo component turret package contains a size 11 motor-tachometer, gearhead and potentiometer

ROTATING SERVO COMPONENTS assembled in miniature turret packages require less volume and are better suited to vibration and shock than many conventional rotating component packages which line up the components end-to-end. The turret concept developed by Mechatrol, a division of Servomechanisms, Inc., Westbury, N. Y. also permits more flexible use of servo components. A single servo motor can be used to drive more than one component, each at the same or different gear ratios. The output shaft is designed for easy connection to other components or sub-assemblies.

Adding Components

The illustration shows a typical turret package containing a size 11 motor-tachometer, a gearhead, and a potentiometer, all encased in a package 5 in. long, with a nominal OD of 2¼ in. Other servo components, such as transistorized amplifiers and synchros, can be added as needed. Clutch and limit stops may be added at various stages of the gear train.

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Spark Test	3000 volts RMS	4000 volts RMS
Dielectric Strength	2000 volts RMS	3000 volts RMS
Power Factor	.005 Max.	.005 Max.
Dielectric Constant	2.2 Max.	2.2 Max.
Insulation Resistance	>5000 meg/1000'	>5000 meg/1000'
Moisture Absorption	Nil	Nil
Flammability	Non flammable	Non flammable
Solvent Resistance	Unaffected by any commercial reagents	Unaffected by any commercial reagents

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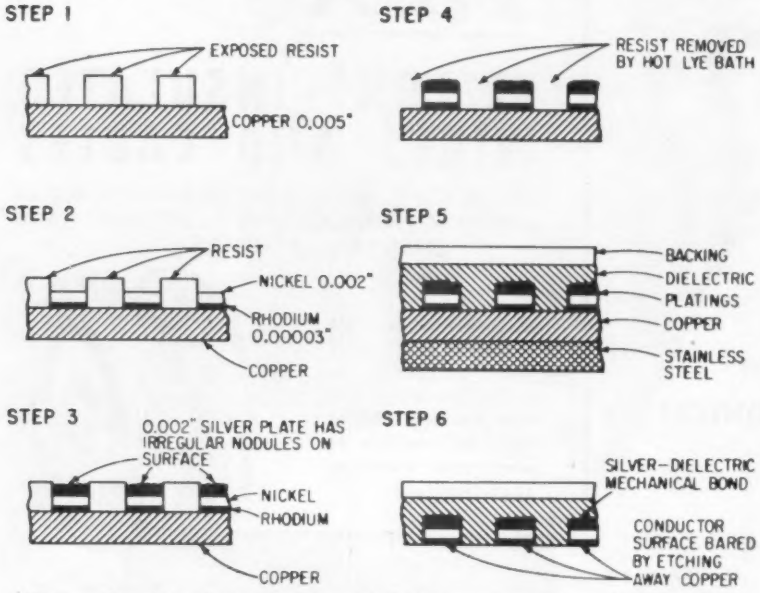
Copper Is Temporary Base for Inlaid Circuits



Photographic, electroplating, pressing and etching processes are combined to produce large lots of inlaid circuits with flush conductors

INLAID CIRCUITS, electrical conductors flush with the surface of the surrounding dielectric, are particularly useful with sliding contacts. Main applications are miniature tap switches, commutators, coding discs, cross-over switches and computer parts.

Method of producing inlaid circuits, developed by Glass Products Co., Santa Barbara, Calif., differs substantially from a technique reported here October 1, 1957. The process is basically chemical and does not require finish machining. Nodules which grow on plated silver provide the mechanical bond between the conductor and the insulating base material.

Oversized artwork master furnished by customers or prepared by Glass Products is photographed by a reducing camera onto glass. This is used to print multiple images of the circuit, in actual size, on glass plates. Plates, usually 12 by 17 inches, may contain up to 200 prints of smaller circuits, such as commutators.

Next, the following production steps are followed, as shown in the diagram:

(1) A sheet of 0.005 inch copper the size of the plate is treated with light-sensitive resist, generally containing potassium dichromate. The sheet is exposed in a vacuum frame using the plate as a negative. The exposed areas of the resist are set and the unexposed areas washed in a warm water bath.

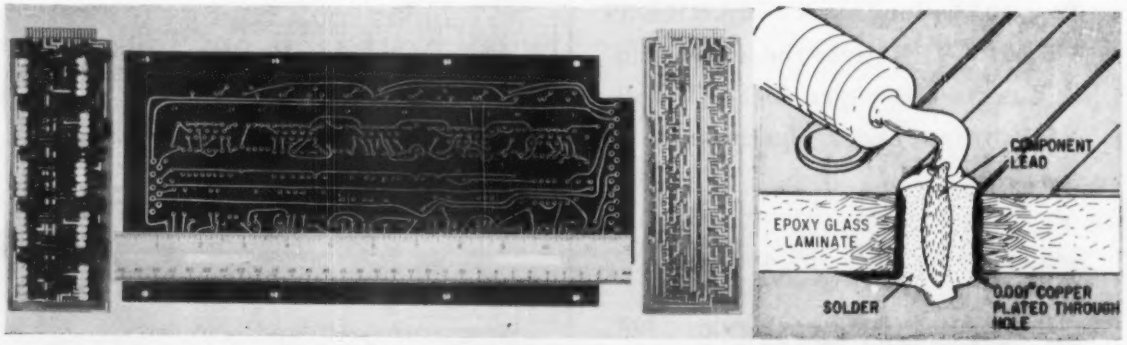
(2) The bare copper pattern is electroplated with various metals. Metals and plating thicknesses depend on circuit requirements. A common combination is a 0.00003 inch layer of rhodium followed by a 0.002 inch layer of nickel.

The rhodium provides a smooth, corrosion-resistant final surface. Occasionally, a flash of gold is first deposited as a lubricating surface for the contact to slide on. The heavier layer of nickel gives the circuit a hard body.

(3) A layer of silver, 0.002 inch thick, goes on top. Irregular nodules on the silver grip the backing plate of plastic or metal used for the circuit board.

(4) The plated copper sheet is

DESIGN TRENDS: Padless Printed Wiring Board



Conventional printed wiring boards use a pad around component lead holes to ensure a strong solder fillet. Photo shows a conventional board flanked by miniaturized versions. 1/5th the size, developed by Photocircuits Corp., Glen Cove, N. Y. Size reduction is achieved by eliminating space required for the pads. Holes are plated through so that solder joints are made primarily inside the holes. The firm reports that experimental boards, with 40 mil holes, 40 mil conductors and 40 mil spacing between holes, passed temperature, vibration and shock tests of MIL-E-5272. Pull strength of connections is 20 pounds in 40 mil G10 board and 12 pounds in 1/32 inch XXP. Close registration between printing and hole fabrication operations is required

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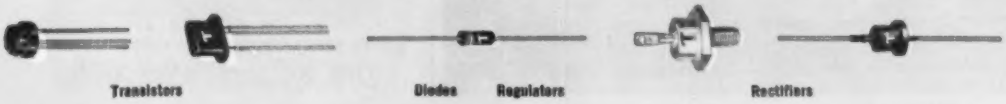
TM156	1500	200	.5
TM124	1200	1000	.5
TM125	1200	400	.5
TM126	1200	200	.5
TM104	1000	1000	.5
TM105	1000	400	.5
TM106	1000	200	.5

Transitron

electronic corporation wakefield, massachusetts



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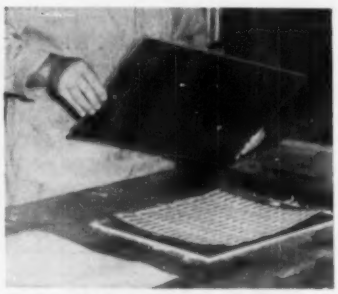
immersed in hot lye bath to remove remaining resist.

(5) The sheet is placed, plated side up, on a stainless steel plate for rigidity during pressing. A thin sheet of adhesive and a sheet of dielectric material are applied, followed by backing material.

Phenolic, melamine, epoxy, or combination of these, are used as dielectrics. When a phenolic laminate is used, uncured sheets of phenolic paper are laid against the silver without adhesive. When melamine is desired, it is used uncured as the adhesive and becomes the dielectric when cured. Phenolic laminates, mylar, aluminum and many other metals have been used as circuit backing.



Sandwiches of 90 commutators each are prepared for insertion in hydraulic press

The sandwich is subjected to approximately 1,400 psi at a temperature of 305F in a hydraulic press. This forces dielectric into fillets formed by plated material and copper sheet so that the dielectric assumes the same plane as the material first plated.

(6) The processed sandwich is bathed in ferric chloride until all the copper is removed, leaving the plated conductors flush with the dielectric surface. If the rhodium layer is very thin, there is a chance it may be porous enough to allow the acid to reach the nickel. In that case, chromic acid is used since it will dissolve copper but not nickel nor rhodium. Acid will not become trapped in the dielectric (which could cause electrical leakage) due to the smooth surface given by the copper sheet.

Finally, the circuits are sawed apart and cleaned.

When an ultra-smooth surface

After pressing, copper plating base is etched away in tank

finish is required, the sheet copper is not used. A layer of copper 0.0002 inch thick is chemically reduced on optically polished glass. After masking, plating and pressing, the glass plate is pulled off and the copper etched away.

Strong cross-over connections may be made by laying up additional layers of resist and conducting material over the plated circuit at the sandwich stage. The cross-overs will be under the circuit after the copper sheet is etched away. The resist pattern is applied with a silk screen.

Micrometers Change Cut and Strip Setup

FAST SETUP changes through use of micrometer-type adjusments features a high-speed wire cutter and stripper made by Eubanks Engineering Co., Pasadena, Calif.

Standard models handle solid or stranded wire from 32 AWG to 3/16 inch OD. Cutting lengths are 1 inch to 300 feet. Strip lengths are 1/8 to 1 inch, to maximum strip combinations of 1 by 3/8 inch

Operator adjusts wire travel speed. Installation at Beckman Instruments includes a Reevelec induction heating unit

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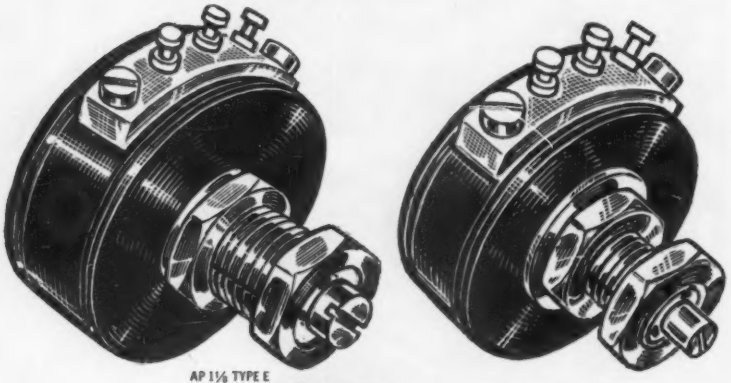
NOW... Mil-Spec miniature precision, 125°C*

POTS

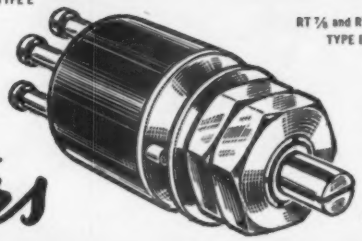
at mass production prices...



AP 1⅛ TYPE E

RT ⅞ and RTS ⅞ TYPE E

by Waters



AP ½ TYPE E

ORDER TYPE E TODAY AND SAVE UP TO 50%!

E = EXCELLENCE + ECONOMY, you'll soon agree, when you get a quotation on Waters Type E Precision Potentiometers from your nearby distributor. He has them in stock . . . ready for fast delivery at prices that pass along to you the benefits of Waters' unique mass-production techniques. Nowhere else can you match the prices you pay for potentiometers with the following features:

HIGH-PRICED FEATURES AT NEW LOW COST

***ENVIRONMENTAL SPECIFICATIONS**
MIL-E-5272A and MIL-R-19

***LIFE EXPECTANCY**
MIL-R-19 where applicable

BODY AND COVER
Anodized aluminum, precision machined, for high dissipation rating (2 to 4 watts)

BUSHINGS
Corrosion resistant alloy, precision bored, choice of plain or split in all sizes (except RTS ⅞)

TERMINALS
Turret type, gold flashed over silver plate for ease of wiring.

ELECTRICAL CONNECTIONS
All important internal connections welded, other connections high-temperature soldered.

WINDING AND SLIP RING CONTACTS
Precious metal

TEMPERATURE COEFFICIENT OF WIRE
0.00002 parts per °C

EQUIVALENT NOISE RESISTANCE
140 ohms, maximum

DIELECTRIC STRENGTH
1000 volts DC for one minute at sea level

NEW BULLETIN "E" gives complete details about standard mechanical and electrical specifications, dimensions and part numbers of these high precision, low-cost potentiometers. Get your copy right away from your nearest Waters distributor or write direct to Waters at Wayland.

Contact your local distributor

Electrical Supply Corporation
205 Alewife Brook Parkway
Cambridge 38, Massachusetts

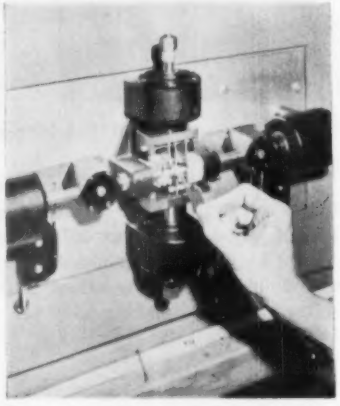
General Radio Supply Corp.
600 Penn Street
Camden 2, New Jersey

Wholesale Radio Parts Co., Inc.
308-310 W. Redwood Street
Baltimore 1, Maryland
Branches in: York, Pa; Lancaster, Pa. Harrisburg, Pa.

Waters® MANUFACTURING, INC.
BOSTON POST ROAD, WAYLAND, MASSACHUSETTS

or 7/8 by ½ inch.

Wire travel speed may be varied from zero to 150 feet a minute. Machine may be set to cut a single wire. Or it will cut and strip 1 inch pieces at 8,600 per hour, 50 inch pieces at 1,970 an hour, and so on.



Blade position determines strip lengths and micrometers adjust cutting depth

Wire length is measured as the wire passes under a measuring wheel. Length is predetermined by a micrometer which controls a ratio unit. Settings are given by a chart on the cabinet.

Strip lengths are changed by shifting positions of cutting blades in a slotted block. Cutting depth is set to within 0.001 inch by micrometers mounted above and below the cutting heads. Compressed air is used to operate the cut and strip mechanism and control wire feed. Construction is modular so assemblies may be separately serviced.

Tape Programs Board Driller

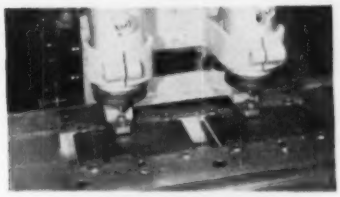
TAPE-PROGRAMMED drill press positioning table has been modified to drill 45 to 60 holes a minute in printed wiring boards. Positioning accuracy is 0.001 inch, sufficient for automatic component insertion.

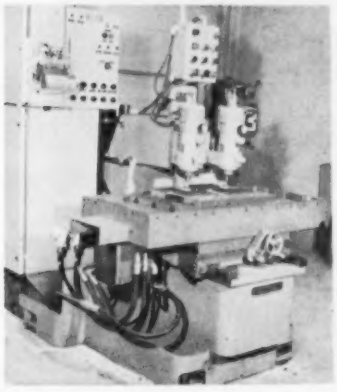
According to Jones & Lamson Machine Co., Springfield, Vt., the cycle may be set at fully automatic or jogged through 1 hole at a time. Cycle may be interrupted at any point for manual operation.

If more than 1 size hole is re-

quired, table may be programmed to drill 1 size hole in all boards of a batch and recycle after drill change. Or, it will automatically interrupt cycle and call for drill changes on each board.

Table travel is 12 inches front to back and 20 inches side to side. Travel speed from hole to hole is 150 inches a minute.





Positioning table is set up under twin drilling heads. More than 2 heads may be used

Tape preparation time averages 5 minutes a hole. Hole locations are reduced to offset dimensions from a starting point. Sequence of operation is chosen and listed. A hand-operated punch is used to punch directions into 4-inch Mylar tape.

Light, Inert Filler

Tiny, hollow ceramic spheres made by Hastings Plastics, Inc., Santa Monica, Calif., may be used as radome and potting compound filler. Chemically inert, dimensionally stable, they may be mixed with liquid epoxy, polyester or phenolic resin. Average particle density ranges from 0.4 to 0.65 gm/cc and moisture absorption after 72 hours at 180F in saturated atmosphere is less than 0.01 per cent.

expanded line of slug-tuned

COIL FORMS

gives you a wider choice...

by *Waters*

RIBBED CERAMIC HIGH-"Q" COIL FORMS NOW AVAILABLE FROM STOCK!

If you need slug tuned coil forms that stand rough treatment and meet military specifications, it will pay you to look into Waters Ribbed Ceramic Coil Forms.

Their silicone-impregnated ceramic conforms to JAN-1-10 Grade L5 or better. Their ribbed construction permits coil leads to be brought under windings to lugs. No loose leads. Also permits highest "Q". Unique construction includes a new permanent tension device. No loose parts.

Like well-known Waters Phenolic Coil Forms, these new numbers come with standard bushing or retractable type. The latter allows core to enter bushing to give more effective winding area. All numbers are designed to be stacked or have bushings on each end for double tuning.

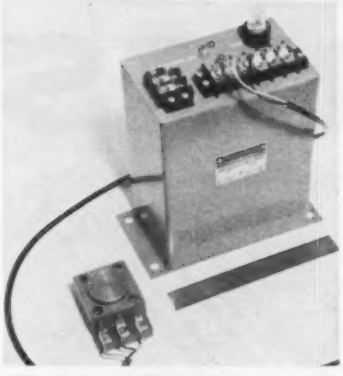
BULLETIN (ED) covers all details about Waters Ribbed Ceramic and Phenolic Coil Forms for frequency ranges from Audio to 250 M.C. and above. Get your copy from your nearby Waters distributor or write direct to Waters at Wayland.

Contact your local distributor

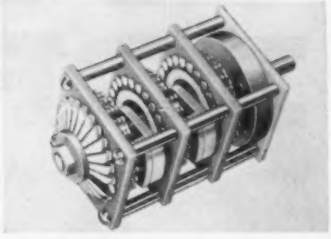
Waters MANUFACTURING, INC.

BOSTON POST ROAD, WAYLAND, MASSACHUSETTS

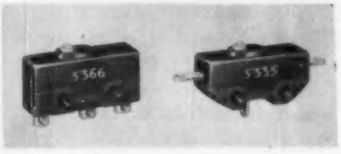
Spotlighting New Switches



Westinghouse Electric Corp.
contactless limit switch

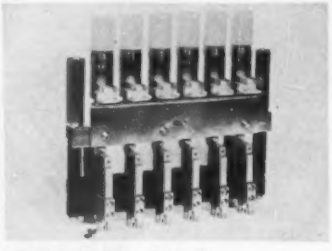


The Daven Co.
progressive shorting type



Haydon Switch, Inc.
molded terminal units

Meletron Corp.
snap-action switch



The Capitol Machine Co.
multiposition device

Hydraulic Research and Mfg. Co.
pressure switch

Switches, in their extremely wide varieties, represent a sizable portion of the components business. Manufacturers are constantly striving for new highs in controlled accuracy and reliability.

Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif., (300) announces the Melematic, a new snap action switch suitable for use where the operating force is specific. It has a resin plastic housing and extruded terminals to prevent stripping of threads.

In production at **Hydraulic Research and Mfg. Co.,** 2835 N. Naomi St., Burbank, Calif., (301) is the new 90,000 series pressure switch with intermediate mechanical snap action that insures trigger switching of the electrical switch element. The unit is qualified and available in pressure settings from 5 to 4,000 psi.

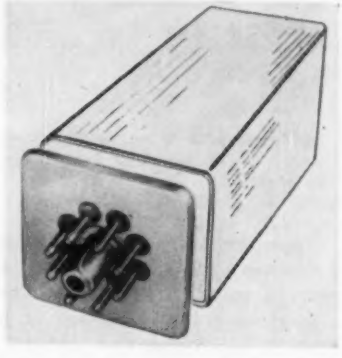
The Capitol Machine Co., 36 Balmforth Ave., Danbury, Conn., (302) has introduced the S-IA series of switches designed for minimum space required behind the panel and use of a No. 327 lamp. Each position has an individual lamp assembly.

A new progressive shorting type switch has been developed by **The Daven Co.,** Livingston, N. J., (303). It shorts out every other position on the switch but the one in use. It is particularly useful in the metering of a single position or for the gathering of pertinent information on it. Switches are available as 20, 24 and 32 pole units.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 22, Pa., (304) now has available proximity limit switches designed for operating life to be independent of switching operations performed. Electrical output is 24 v d-c at 0.335 ampere.

The 5300 series precision switch now being manufactured by **Haydon Switch, Inc.,** Waterbury 20, Conn., (305) is available with a full range of operating forces, from 2 to 20 oz. Terminals, molded into the plastic cover, cannot wobble or be loosened under rough usage.

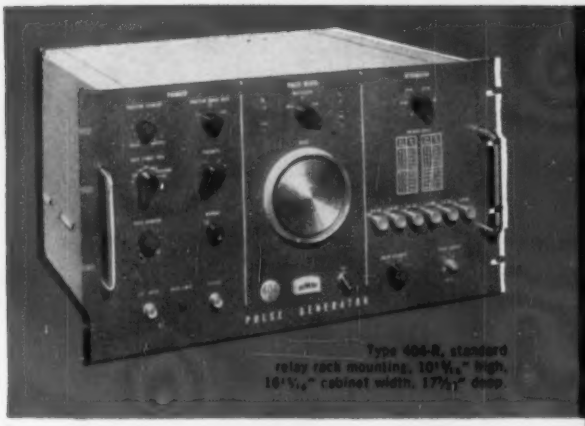
For more information use READER SERVICE Card



One-Piece Headers varied designs

Glasseal Products Co., Inc., 1111 E. Elizabeth Ave., Linden, N. J., has developed a new type of square and rectangular header. The completely sealed header eliminates the usual subassembly operations for electronic manufacturers who use square or rectangular cans to package their units. The new designs are available in nearly every standard size and include moat, square flange, and insert type constructions. **Circle 306 on Reader Service Card.**

(Continued on page 118)

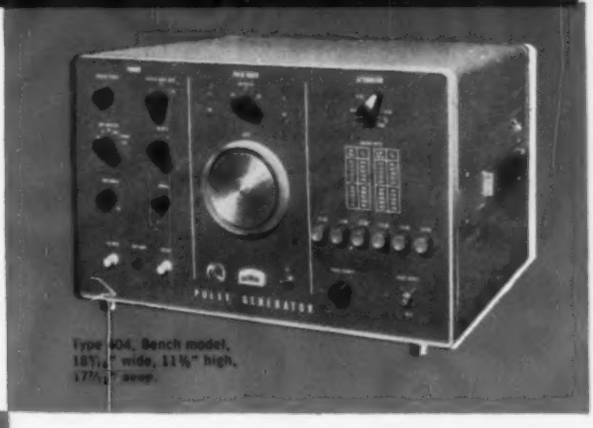


Type 404-R, standard relay rack mounting, 10½" high, 19" cabinet width, 17½" deep

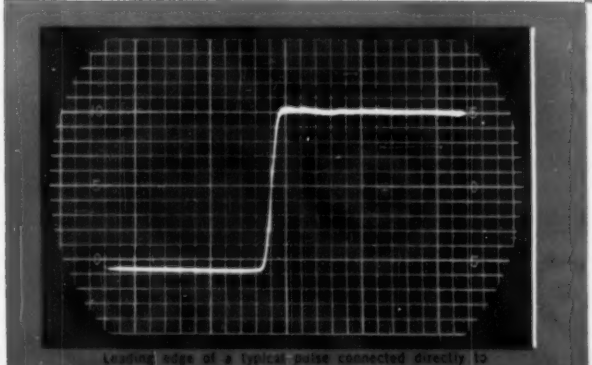
HIGH REPETITION RATE PULSE GENERATORS

DU MONT 404-R
(Rack-mounted)

404
(Bench model)



Type 404, Bench model, 18½" wide, 11⅛" high, 17½" deep.



Leading edge of a typical pulse connected directly to the deflection plates of a cathode-ray tube. Sweep rate is 0.01 usec/scale division.

● The Du Mont Type 404 bench model Pulse Generator and the Type 404-R rack-mounting version are electronically identical, and equal in performance. They are physically different only to satisfy their operational use.

Hard tube circuitry in these pulse generators eliminates jitter, overshoot and ringing inherent in conventional hydrogen-thyratron designs. Repetition rates of 100,000 pps down to single, manually-triggered pulses, plus fast rise time (0.02 usec) and continuously variable pulse widths from 0.05 to 100 usec combine to give these pulse generators outstanding versatility.

QUICK FACTS

- Repetition rate up to 100,000 pps, down to single, manually triggered pulse.
- Maximum jitter between trigger and pulse 0.002 usec, or 0.04% of delay.
- Rise or fall time of pulse, 0.02 usec maximum.
- Continuously variable pulse width from 0.05 to 100 usec.
- Output of 50 volts into a 50 ohm load, positive or negative polarity.
- Calibrated attenuator offers 59.5 db attenuation in 0.5 db steps with no pulse degradation.
- Internal pulse delay from −2 to +125 usec with respect to trigger output.
- May be externally triggered.

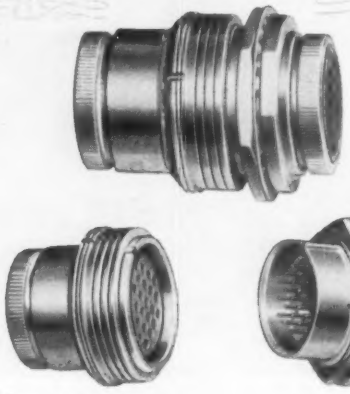
Price: 404-R...$690.00
404.....675.00
f.o.b. E. Paterson, N. J., U.S.A.

DU MONT®
INSTRUMENT DIVISION
ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, N. J., U.S.A.

Make a point to see the new DuMont 401-A low-frequency oscilloscope. Among its many features are identical X & Y amplifiers.
Visit Du Mont at the Wescon Show—Booths 1433 and 1434

All the right connections for

CONTINUOUS PERFORMANCE



Continuous performance under extreme environmental conditions is yours with Deutsch 27-contact miniature connectors. These environmental performers exhibit thrilling qualities:

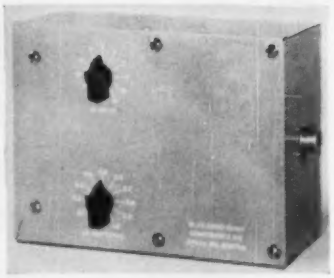
- Available for immediate delivery
- Durable for 500 cycles of engagement
- Seal before and after contact
- Unaffected by altitude pressure variations
- Operate from −67° F. to 250° F.
- Meet or exceed requirements of MIL-C-5015

Shimmy and shake these rugged connectors. They're vibration-dampened and withstand physical shocks up to 100 G's. The exclusive Deutsch ball-lock coupling ring ensures a positive lock without twisting or turning, without lock-wiring or coupling nut. Just push in to connect—pull back to disconnect.

To take a peek at the inside information on Deutsch 27-contact miniature connectors...as well as the 3, 7, 12, 19, 37 and 61 contact members of this environmental troupe...write for data file 8B. Or see them all at WESCON (Booth 949-950).

The Deutsch Company

7000 Avalon Boulevard • Los Angeles 3, Calif.



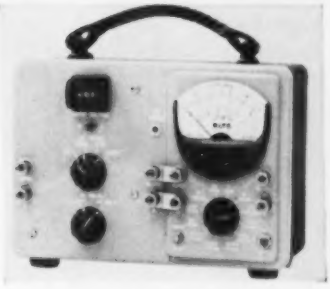
Decade Delay Lines lumped-constant

Epsco Components, 108 Cummington St., Boston, Mass., has developed a new lumped-constant decade delay line featuring high impedance output. The following inputs are available: 500 ohms, 1,000 ohms and 2,000 ohms. Variable from 0 to 11 μsec, in increments of 0.1 μsec, with rise times of 0.25 μsec. Units are provided with coaxial input and output connectors. These delay lines are reported to be ideal for research and laboratory personnel, for work in systems' breadboarding and for general testing. **Circle 307 on Reader Service Card.**

D-C Millivoltmeter differential input

Millivac Instruments, P.O. Box 997, Schenectady, N. Y. The MV-37A differential input d-c millivoltmeter has a high common mode rejection ratio (1,000:1), not only on its sensitive direct ranges but also on its nonsensitive range where the input signal is being attenuated. Attenuator errors be-

tween the two input channels are eliminated by a switching relay which inserts the same input attenuator alternately in either channel. The instrument is expected to find extensive application for computer servicing. **Circle 308 on Reader Service Card.**



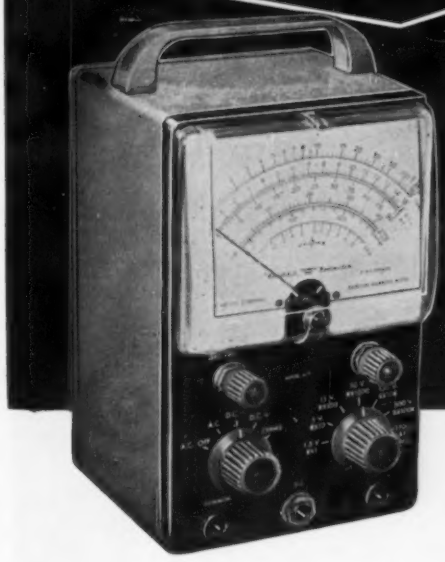
Portable Voltmeter battery-powered

Alto Scientific Co., Inc., 855 Commercial St., Palo Alto, Calif., announces model D-62 battery-powered portable d-c/a-c voltmeter. It can measure a-c and d-c with a maximum sensitivity of 1 mv full scale. Voltage range of the d-c unit is 1 mv to 100 v; of the a-c, 1 mv to 300 v. The D-62 has a d-c accuracy of ± 2 percent, and an a-c accuracy of ± 5 percent. Frequency range of the a-c unit is 5 cps to 200 kc. Input resistance is 10 megohms a-c and d-c. Approximate battery life is 40 hr for the chopper and 130 hr for the voltmeter power source. **Circle 309 on Reader Service Card.**

Chopper connector mounted

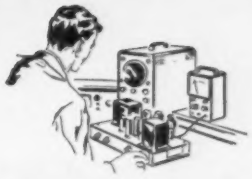
The Bristol Co., Waterbury 20, Conn. Miniature hermetically-sealed Syncroverter switches are now being packaged for the latest

look what $24.50 buys in test equipment!



HEATHKITS GIVE YOU TWICE AS MUCH equipment for every dollar invested

The famous model V-7A Vacuum-Tube-Voltmeter is a perfect example of the high-quality instruments available from Heath at ½ the price you would expect to pay! Complete, only $24.50



Get the most out of your test equipment budget by utilizing HEATHKIT instruments in your laboratory or on your production line. Get high quality equipment, without paying the usual premium price, by dealing directly with the manufacturer, and by letting engineers or technicians assemble Heathkits between rush periods. Comprehensive instructions insure minimum construction time. You'll get more equipment for the same investment, and be able to fill your needs by choosing from the more than 100 different electronic kits by Heath. These are the most popular "do-it-yourself" kits in the world, so why not investigate their possibilities in your particular area of activity! Write for the free Heathkit catalog now!

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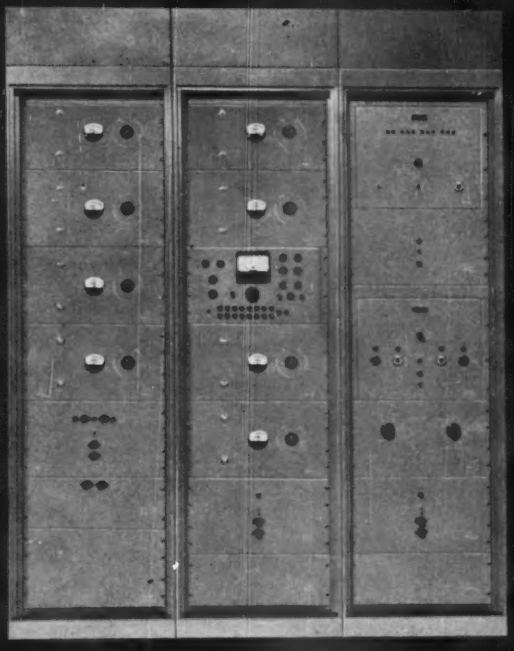
NEW SIMPLICITY OF OPERATION



with Bendix-Pacific

TELEMETERING GROUND STATIONS

Bendix-Pacific FM/FM Receiving Stations have achieved a new high in operational simplicity. Comparator type circuitry, highly stable components and automatic calibration techniques eliminate all controls except channel selection and calibration switches. With Bendix-Pacific stations, high accuracy data can be obtained in a shorter time than ever before.

Bendix-Pacific Receiving Station Systems represent the most advanced state of the art. Two types are available: The **TGRS-100 Receiving Station** is designed for either real time reception and demodulation of signals from FM/FM Telemetry Transmitting Systems or demodulation of tape recorded data. The **TGRS-600 Receiving Station** is designed primarily for precision conversion of tape recorded information from FM to analog.

Bendix-Pacific maintains a complete staff of instrumentation personnel to assist you in the solution of your data problems. Contact —

Bendix-Pacific
DIVISION OF BENDIX AVIATION CORPORATION
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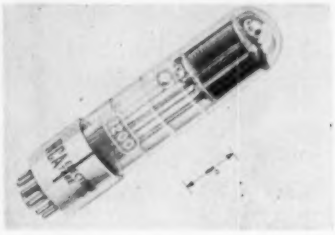
East Coast: (Eastern Representative) P.O. Box 391, Wilton, Connecticut — Dayton, Ohio: 120 West 2nd — Washington, D. C.: Suite 803, 1701 "K" Street, N. W.
Canadian Distributors: Computing Devices of Canada, Ottawa 4, Ontario
Export Division: Bendix International, 205 E. 42nd Street, New York 17, New York

modular-type equipment. These choppers functionally mate with the Cannon K02-16-10SN receptacle and retain the nonresonant performance of the previous models of the same devices. Units are designed to operate at extremes of altitude, temperature, shock, vibration, and acoustic noise encountered in the various military airborne equipment requirements. **Circle 310 on Reader Service Card.**



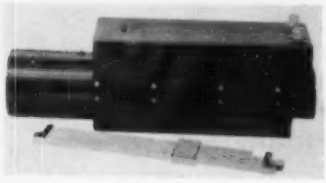
Phototube with u-v response

Radio Corp. of America, Harrison, N. J. The 7200 is a 9-stage multiplier phototube designed especially for the detection and measurement of ultraviolet radiation, and for other applications involving low-level radiation sources. It employs an envelope consisting of a fused-silica section and a graded-seal section. The fused-silica section transmits radiant energy in the u-v region down to and below 2,000 angstroms. Spectral response of the 7200 covers the range from about 1,800 to 6,000 angstroms. The tube has high sensitivity to blue-rich light and negligible sensitivity to red radiation. **Circle 311 on Reader Service Card.**

Digital Timer four-decade unit

Erie Resistor Corp., 644 W. 12th St., Erie, Pa. Model 2400 is a miniature four-decade digital timer

having a time resolution of 1 millisec and a maximum indicated time interval of 9.999 sec. Glow transfer tubes are used as decade counters and indicators. Pulses derived from a 1,000 cps tuning fork are fed to a gated amplifier which is controlled by miniature "start" and "stop" thyratrons. The thyratron gate control circuitry reduces the normal requirement of ten triodes to a total of two miniature gas-filled tetrodes. Overall dimensions of the timer are 6 in. by 7 in. by 4¾ in. Model 2400 is designed to meet specification MIL-T-945A. **Circle 312 on Reader Service Card.**



TWT Amplifiers
S-band units

Hughes Products, International Airport Station, Los Angeles 45, Calif. The MAS-1A is an S-band periodically focused twt amplifier with power outputs of 1 kw over a frequency band of 2,000 to 4,000 mc. Peak power outputs are obtained with duty cycles up to 0.005 when operated with 1 w drive. The tube has a gain of 30 to 33 db, giving an excess of 1 kw over most the band. The type of p-m focusing field employed eliminates the solenoid, solenoid power supplies, and solenoid heat dissipation. **Circle 313 on Reader Service Card.**

Repeater Servo
modular design

Waldorf Instrument Co., Huntington Station, L. I., N. Y., has developed a complete miniature plug-in potentiometer servo repeater system. The model W 1902 is a self-contained servo measuring

HELIPOT's newest potentiometer... the single-turn, 1-1/16" A.I.A. diameter, all-metal series 5200... fends off 2,000 cps at 30G's, repels 10 cycles NAS 710, procedure III humidity, rides out 50G's shock and 100G's acceleration.

We're tough, too... on the 5200's mechanical tolerances. Register face, diameter and shaft runouts are all held to 0.001" max... spring-loaded shaft eliminates endplay.

All this with linearity to ± 0.15%... power rating of 3 watts at 100°C (derating to zero at 150°)... 250 to 100,000 ohms standard resistance range... *and certified test data to prove our every claim.*

What a pot for airborne applications... at a down-to-earth price! *Write for data file A 82 for the proven facts.*

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Helipot Corporation, Newport Beach, California
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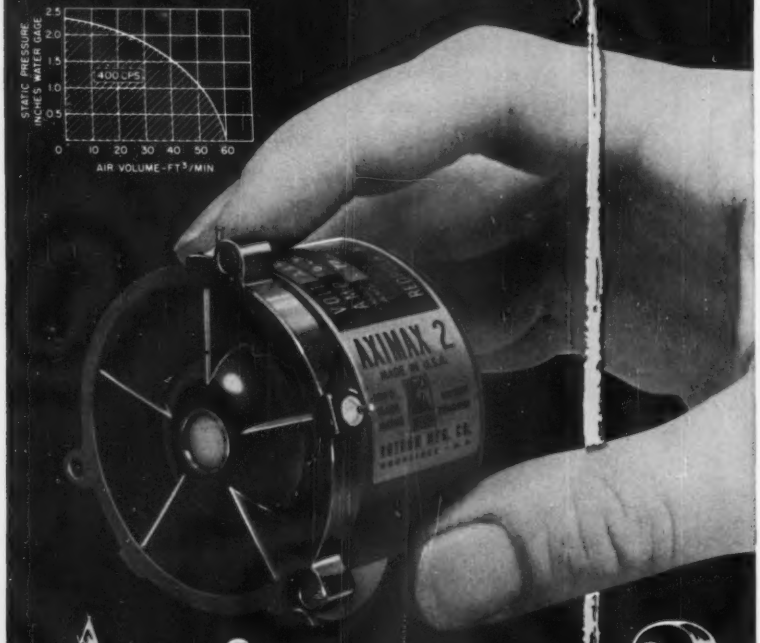
Engineering representatives in 27 cities.

potentiometers... dials... delay lines...
expanded scale meters...
rotating components... breadboard parts

1431

Built to aircraft and missile specifications

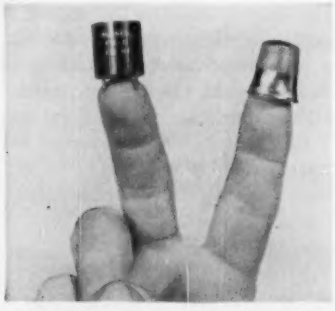


Aximax 2

The Aximax 2 vane axial fan is designed for tightly packed "black boxes" aboard aircraft or missiles where maximum cooling is mandatory with a minimum of space and weight loss due to the fan. Air delivery of 60 cfm free air is attained from a fan only 2" in diameter by 1.5" in axial length. Weight is 4.5 ounces. Variation in driving motors include constant speed 20,000 rpm, 10,000 rpm as well as variable speed Altivar versions. The latter vary their speed inversely with density thereby approaching constant cooling with a minimum of power drain and noise. Power requirements vary from 400 cps for the standard unit to 1600 cps for special designs. 1 or 3 phase, sinusoidal or square wave. The Aximax 2 meets MIL-E-5400B and other individual missile specifications. Write today for complete technical information to —

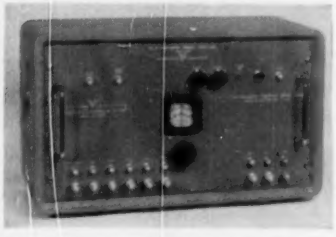
ROTRON mfg. co., inc.
WOODSTOCK, NEW YORK
In Canada: The Hoover Co., Ltd., Hamilton, Ont.

1¾ in. in diameter, 4 in. in length, and weighing only 13 oz. Unit includes a servo amplifier, servo motor, potentiometer (single or multi-turn), input power stepdown transformer, and gear train. **Circle 314 on Reader Service Card.**



Variable Toroid encapsulated

Burnell & Co., Inc., 10 Pelham Parkway, Pelham, N. Y., has announced a subminiature encapsulated variable toroid equivalent in electrical specs to the types AT-11 and AT-12 Adjustoroids. Developed especially for printed circuit and similar light weight applications, this variable toroid is completely hermetically sealed as there is no physical contact between the adjusting screw and the toroid itself. Stepless adjustment of inductance over a 10 percent range is provided and torque adjustment is such as to preclude possible strain on p-c mounting. **Circle 315 on Reader Service Card.**



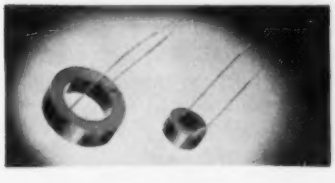
Phase Detector 1 percent accurate

Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J. Type 205B phase detector is designed for phase measurement from 15 mc up to 500 mc, with an

error of 0.05 deg or 1 percent of the dial reading. It is suitable for measuring performance characteristics of radar amplifiers, r-f cables, or other transmission networks where constant time delay for all frequency components is important for faithful transmission of signals. Essentially, the instrument consists of a continuously variable coaxial delay line, two step variable coaxial delay lines and a vector sum amplifier with separate amplitude adjustment. **Circle 316 on Reader Service Card.**

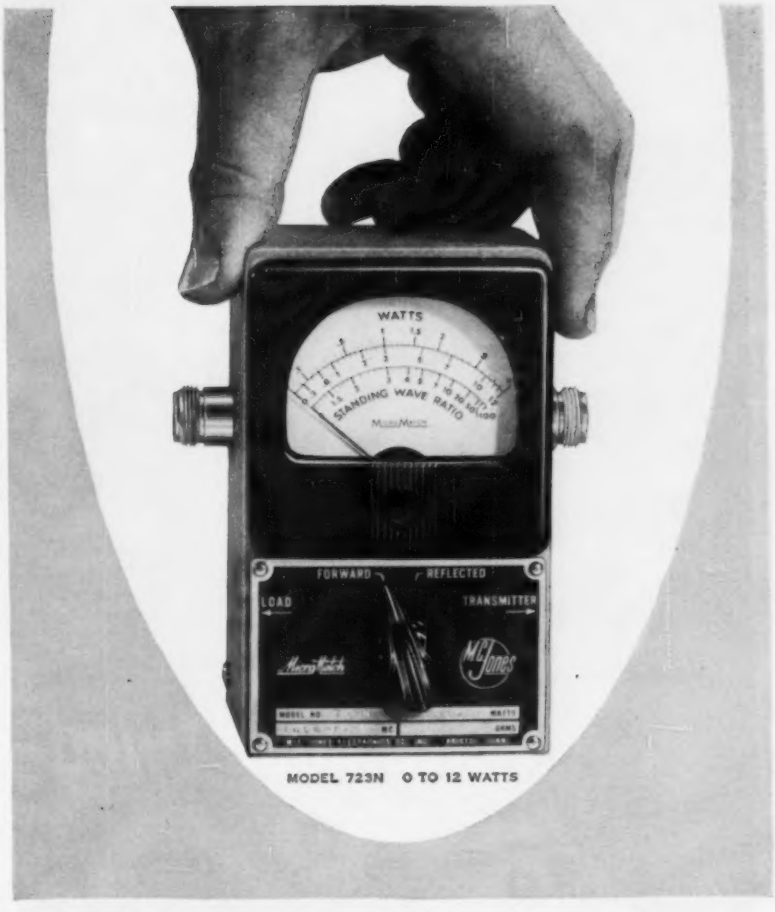
Pulse Transformer gap-firing

LEVINTHAL ELECTRONIC PRODUCTS, INC., 760 Stanford Industrial Park, Palo Alto, Calif. A new gap-firing pulse transformer is recommended for application in crowbar protective circuits to 100 kv. It is rated for a secondary peak voltage of 135 kv, a maximum pulse width of 0.5 μsec, and a maximum duty of 0.002. The turns ratio is 1 to 15, step-up polarity-inverting. **Circle 317 on Reader Service Card.**



Magnetic Coils high temperature

PRECISION, INC., 730 Lyndale Ave. North, Minneapolis, Minn., has developed a group of high temperature magnetic coils designed for critical applications under exacting conditions of humidity, temperature, shock and vibration. Units are available in sizes ranging from ¼ in. to 2¾ in. diameter and are built to specification. Moisture



VSWR and RF WATTMETERS

25 MCS TO 3000 MCS

These rugged, compact units accurately measure and indicate the RF power and VSWR of coaxial transmission lines. Each type combines a frequency insensitive bidirectional coupler and complete indicator circuit in one small case. Accuracy of power measurement is ± 5% of full scale.

Model No.	Frequency Range (Mcs)	Power Range (Watts)	RF Connectors
712N	25—1000	0-2.5; 5; 10 in 3 scales	N*
723N	1000—3000	0-12 in one scale	N†

** Also available with UHF, BNC and Type C connectors*
† Also available with BNC and Type C connectors

For more information please write for 68-page catalog No. 12 or see Electronics Buyers' Guide or Electronic Engineers Master.

U.S. Letters Patent No. 2,588,390

M.C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

"Termaline" 50 ohm coaxial line Load Resistor
"Thruline" Directional RF Wattmeter
"Termaline" RF Absorption Wattmeter
...a need filled
Coaxial RF Switches
Coaxial RF Filters

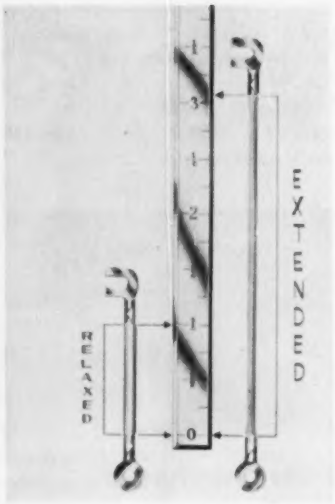
Since 1942 the Bird Electronic Corporation has met the challenge of a constantly growing electronic industry. Today, enlarged engineering facilities demonstrate our intention to maintain leadership in our field. A wide range of coaxial line instruments and accessories are being designed to meet a variety of specifications; and new applications are continuously being sought.

In addition to experience and established leadership, Bird has the physical facilities to produce and dependably deliver coaxial line instruments and accessories meeting your highly exacting requirements.

VISIT BOOTHS 1529 & 1530 AT WESCON SHOW

BIRD ELECTRONIC CORP.
EXpress 1-3535
1800 E. 38 St., Cleveland 14, Ohio
Western Representative:
VAN GROSS COMPANY • Woodland Hills, California

absorption is negligible under conditions of high humidity. Unit will withstand temperatures up to 350 F for 100 hr and show no evidence of shorted turns in subsequent tests. **Circle 318 on Reader Service Card.**



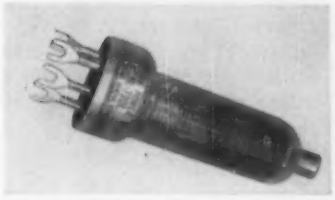
Stretch Cable silicone type

STRETCH WIRE CORP., P. O. Box 893, New Rochelle, N. Y. The new silicone stretch cable can be easily extended 200 percent and retracted to its original relaxed size. The cable is durable, highly resistant to abrasion and wear, as well as oil or chemical attack. Dielectric strength is 550 v per mil. It can be used where extremes of temperature have to be met. The brittle point is less than −150 F and +375 F. Tensile strength is 1,500 lb per sq in. Terminations are in spades, clips, jacks or connectors as required. **Circle 319 on Reader Service Card.**

Rare Earth Ferrite for microwave use

MICROWAVE CHEMICALS LABORATORY, INC., 282 Seventh Ave., New York 1, N. Y., is now producing YIG, yttrium-iron garnet. It has extremely low loss characteristics and is said to have a lower noise factor than ferrites currently available. YIG has a ferrimagnetic

resonance line-width of 55 oersteds at 9,000 mc and 30 oersteds at 3,000 mc. Saturation magnetization is also very low. Applications include isolators, rotators, and paramagnetic amplifiers. Company's present commercial production of YIG can be had in either rectangular or cylindrical shapes. **Circle 320 on Reader Service Card.**



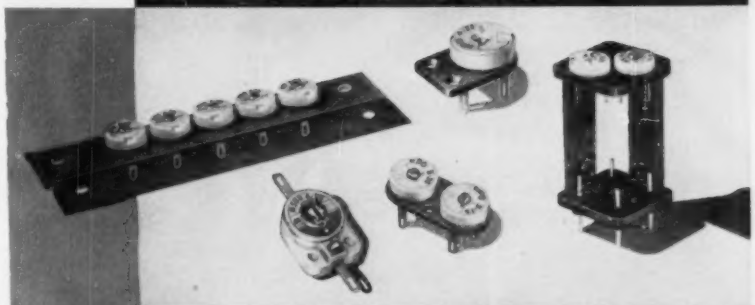
Thyratron
new lug base

NATIONAL ELECTRONICS, INC., Geneva, Ill. A new 2.5 ampere d-c thyratron (NL-710L) is an argon-mercury vapor type with the new lug base. The spade terminals of the lug base make positive contact and eliminate socket heating and associated troubles. Ratings are: filament volts, 2.5; filament current, 9 amperes; anode current, 2.5 amperes d-c; peak anode current, 30 amperes; and peak inverse and forward volts, 1,500. **Circle 321 on Reader Service Card.**

Voltmeter-Amplifier
10 μv to 1,000 v

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J. Model 98-A differential d-c voltmeter-amplifier is designed to

STABILITY
under exacting conditions
FIDELITY
to specifications
UNIFORMITY
of capacity change



make ERIE CERAMICON® TRIMMERS a favorite for
ELECTRONIC INSTRUMENTS
TEST EQUIPMENT and
MILITARY APPLICATIONS

ERIE Ceramicon Trimmers have an enviable reputation for the qualities that are most needed for satisfactory performance. They are dependably true to specifications. They have remarkable stability under the most exacting conditions. They have a capacity change that is practically uniform throughout the full range.

The unique connecting strap on Ceramicon Base Trimmers eliminates the possibility of intermittent contact between the adjusting shaft and the silver pattern. Fired silver electrodes are applied to top of base and rotor, so that capacity is smoothly changed by varying the area of overlap.

ERIE Ceramicon Trimmers and Custom Trimmer Assemblies are available in a wide variety of temperature compensating characteristics and exceed the electrical requirements for MIL-C81A.

These Erie Trimmers are widely used in electronic instruments, test equipment, and military applications. The smaller size basic ERIE 557 Trimmer offers exceptional advantage in miniaturized custom designed assemblies.

Complete description of all ERIE Standard Trimmers is included in Catalog 314-1 . . . Write for it.

ERIE Electronics Division
ERIE RESISTOR CORPORATION
MAIN OFFICES: ERIE, PA. U.S.A.
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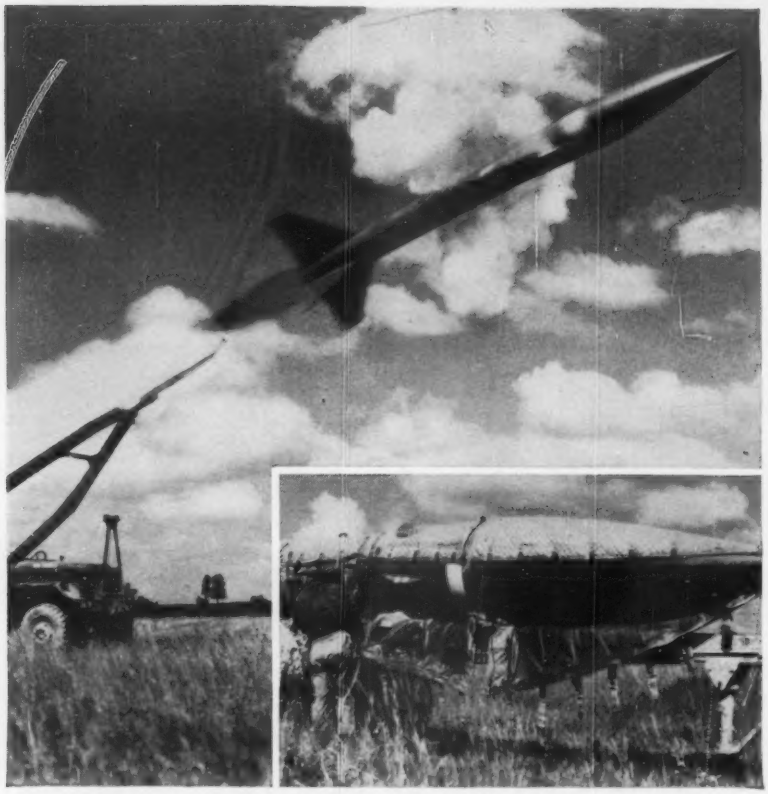


HONEST JOHN artillery rocket depends on G-E electric heating blanket (inset) to bring missile to uniform operating temperature before launching.

HONEST JOHN FIRING SHOWS HOW . . .

General Electric Specialty Heating Maintains Propellant Temperature

Successful launch—and flight—of the Honest John depends upon exact propellant temperature at the moment of firing. A General Electric heating and insulating blanket—which shrouds missile from nose to nozzle—provides and maintains that temperature!

Proper operation of many types of land and airborne equipment, especially at low temperatures, often depends on controlled heat in the right places at the right time. Experienced G-E heating engineers, backed by complete facilities, have already solved thermal conditioning problems on applications ranging from complete missiles and airborne systems to tiny test instruments.

LET US ANALYZE YOUR HEATING PROBLEM. Whether you need a custom-made prototype, or quantity production, investigate G-E "one stop" service for specialty heating products tailored to your specific needs.

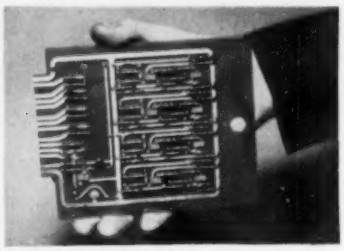
FOR MORE INFORMATION contact your General Electric Aviation and Defense Industries Sales Office or send coupon.

General Electric Company
Section G220-11, Schenectady 5, N. Y.
Please send bulletin GEA-6285A, G-E Specialty Heating Equipment
. . . for immediate project
. . . for reference only
Name . . . . . .
Position . . . . . .
Company . . . . . .
City . . . . . **State** . . . . . .

Progress Is Our Most Important Product

GENERAL ELECTRIC

facilitate testing and measuring of d-c voltages which are off ground or superimposed on larger d-c voltages etc. The unit is direct reading in the range of 10 μv to 1,000 v. It incorporates a high impedance, dual input, extremely well balanced to ground and capable of common mode rejection of better than 80 db. It utilizes a 60 cycle rejection filter which reduces stray 60 cycle effects by more than 60 db. As a d-c amplifier it has a maximum gain of 70 db and is capable of amplifying the differential voltage input to provide an output of $\pm$0.5 ma into a 1,500 ohm load or $\pm 1\frac{1}{2}$ v unloaded. **Circle 322 on Reader Service Card.**



Decimal Counter
transistorized

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa., announces an all transistorized decimal counter on a single plug-in card. The unit will provide a four line 1-2-4-8 output code, with 4 ma drive available directly from each of these lines, to do useful work in recording operations. It is designed to operate from negative pulses of approximately 2 v amplitude and 1 to 2 μsec in duration, and at operating speeds from 0 to 150 kc. All inputs and outputs are provided through a single 18 tab p-c connector. **Circle 323 on Reader Service Card.**

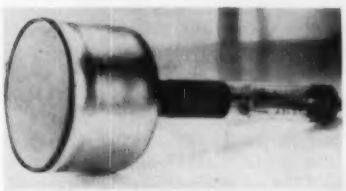
Alloys
high temperature

TECHALLOY CO., INC., Rahns, Pa., has developed super alloys for a variety of high temperature applications, in wire, rod and strip form. They are available in cold-drawn wire and rod in sizes from $\frac{1}{2}$ in. to 0.002 in. diameters and in thin strip, 0.040 in. to 0.005 in. in

widths up to 6 in. **Circle 324 on Reader Service Card.**

Power Supplies transistorized

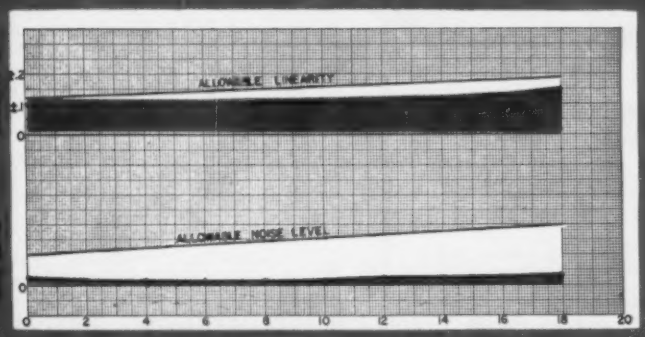
Power Designs, Inc., 89-25 130th St., Richmond Hill 18, N. Y. Model 1515 is one of a family of portable transistorized power supplies protected by Robotec, a transistorized electronic circuit producing simultaneous current and voltage cutoff upon external short circuit. The circuit operates in 30 μsec reducing line input power to a negligible value holding the power supply cut off until manually reset. The power supply is also prevented from being turned on if the output terminals are short circuited. Range of the unit is 1-15 v d-c, 0-1.5 amperes. Regulation is better than 15 mv or 0.05 percent; response time, less than 50 μsec. **Circle 325 on Reader Service Card.**



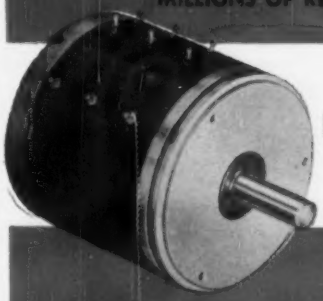
Radar Picture Tube high resolution

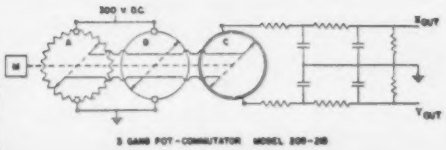
Westinghouse Electronic Tube Division, P. O. Box 284, Elmira, N. Y., has available a high resolution radar picture tube (WX3751) for use in radar and other military and industrial systems. It produces

With CARBON FILM POTS you get life of 18,000,000 revolutions



MILLIONS OF REVOLUTIONS AT 625 R.P.M.





3 GANG POT-COMMUTATOR MODEL 208-2B

PROBLEM

Airborne radar antenna mounted adjacent to rapid fire guns rotates continuously at 625 rpm. Pot pick-off on mount indicates antenna position on a scope. Effective linearity of pot ±.12%. Ambients −73°C to 71°C, sea level to 60,000 feet, humidity, shock, vibration per MIL-E-5272A. Pot must operate to specs for 500 hours at 625 rpm, equivalent to more than 18,000,000 revolutions.

SOLUTION

Precision carbon film potentiometer ganged with C.I.C. commutator cups meet all performance requirements, with a life well beyond 18,000,000 revolutions at 625 rpm on production-line units.

The vacuum surface of the carbon film combined with its natural lubricative properties insures long life at high speed. Wipers are not required to follow the contours of wire windings, therefore, with very low brush pressures which enhance pot life, no wiper bounce occurs at high speeds.

The continuity of the resistance element does not depend upon a single hair-like wire. Failure of the potentiometer therefore does not occur suddenly, but any deterioration of performance is gradual. This fail-safe characteristic enhances reliability, and insures against catastrophic system failure at critical times

Your critical pot requirements can readily be met with C.I.C. Precision Carbon Film Pots and Commutators. We welcome your inquiries.

C I C COMPUTER INSTRUMENTS CORPORATION

92 Madison Avenue · Hempstead, N. Y.

CONQUEST OF SPACE

There are some who find fulfillment in boundless outer space. And more power to them!

But those of us who still have our feet on the ground also find real challenges in less expansive surroundings.

With the aid of a medium-power microscope and several years' experience with fluorochemical designs, we successfully pack 4 filter reactors and a 350 VA power transformer into 60 cubic inches of hermetically sealed inner space. Result is 6 pounds of streamlined reliable power for small space platforms...proved in performance in '58-model missiles and (pardon the expression) aircraft.

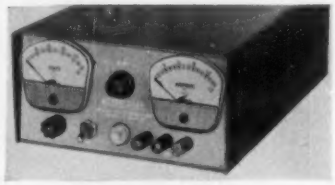
Have slide rule... will travel. You can reach us at:

Raytheon Manufacturing Company
Magnetic Components Department
Section 6120
Waltham 54, Massachusetts

RAYTHEON

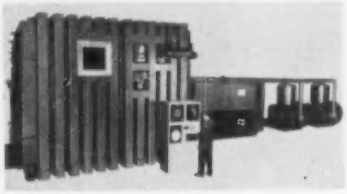
Excellence in Electronics

667 lines to the inch or a scanning line only 0.0015 in. wide across the 5-in. faceplate. This is one-third the width of scanning lines produced by previous tubes. The tube is 13 in. long and is of the electrostatic focus, magnetic-deflection type. **Circle 326 on Reader Service Card.**



V-R Power Supply transistorized

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N.Y. Model SC-36-0.5 compact supply delivers 0-36 v, 0-0.5 ampere. Regulation for line or load is less than 0.1 percent or 0.003 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μsec. Stability for 8 hours is less than 0.1 percent or 0.003 v, whichever is greater. Operating temperature range is 50 C maximum. Temperature coefficient is less than .05 percent per deg C. Output impedance is less than 0.04 ohm. **Circle 327 on Reader Service Card.**



Altitude Chamber walk-in type

AMERICAN RESEARCH CORP., Farmington, Conn. Although this walk-in altitude chamber has a free test space of 10 ft by 12 ft by 12 ft deep, it is completely pre-tested at the factory before delivery. Thorough performance checking is necessary there because the chamber must reduce pressure to a simulated altitude of 100,000 ft in seven minutes. Temperature range

Using Thermistors

Edited by
FENWAL ELECTRONICS

THERMISTOR PROBE ASSEMBLIES

Fenwal Electronics' new thermistor probe assemblies enormously simplify an engineer's design and development problems. Developed and built by Fenwal to your specifications, each assembly is a ready-to-use, easy-to-handle unit incorporating all the qualities that make Fenwal Electronics' thermistors outstanding — sensitivity, stability, reliability, fast response, light weight, and small size.

Three examples of complete thermistor probe assemblies Fenwal Electronics has designed and built to customers' specifications.

Fenwal Electronics develops and builds complete assemblies to various configurations and temperature ranges for specific applications. Probes can be completely interchangeable, and have identical resistance-temperature characteristics.

Engineers: Fenwal Electronics now has a thermistor kit No. G200, which includes 12 different individually packaged thermistors, each with complete data, for development work. $19.95 f.o.b. Framingham.

Write FENWAL ELECTRONICS, INC., 27 Mellen Street, Framingham, Mass., for Bulletin EM-13, describing nine of the many thermistor probe assemblies Fenwal Electronics can build for you. Or write for the Fenwal Electronics catalog (EMC-2).

Fenwal Electronics

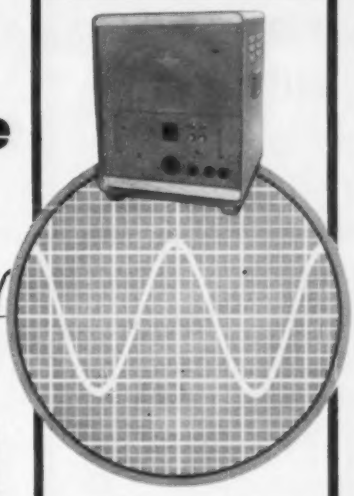
Design — Engineering — Production of Precision Thermistors

CIRCLE 94 READERS SERVICE CARD

NEW 400 cycle DEVR

eliminates distortion

regulates voltage



Model 104 Distortion Eliminating Voltage Regulator responds to transient surges and harmonics, as well as to normal variations from line and load changes . . . corrects for pure sine wave deviations up to 20% in less than 125 microseconds.

It cuts man-hour loss in design and manufacture of aircraft and missile electronic systems where line fluctuations or distortion cause inaccuracies . . . increases servo and computor stability and accuracy . . . is invaluable for standards and other laboratories where highest instrument accuracy is essential. By eliminating surges, it increases equipment life.

Price: $1875 f.o.b., Carlstadt, N. J. Also in 60 cps model. Write today for complete facts.

SIMULTANEOUSLY AVAILABLE

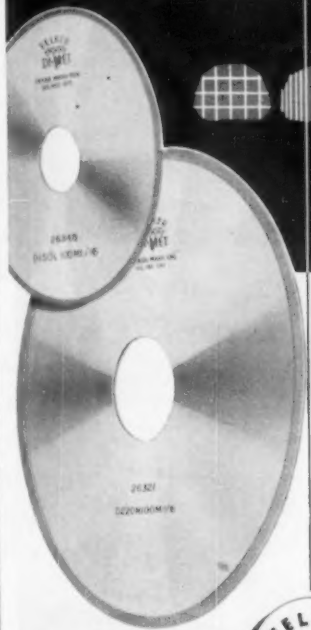
- **1.4 KVA** — regulation ± 1% electronically; response 125 microseconds; distortion elimination to less than 0.3%
- **4 KVA** — regulation ± 1% electromechanically; response 20 V/sec

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION · CARLSTADT, N. J.

CIRCLE 95 READERS SERVICE CARD

You can reduce GERMANIUM WASTE

with these new paper-thin ***Felker Diamond Blades!***



Here's good news to *all* crystal cutters, germanium, quartz, silicon, barium titanate, etc.! Felker DI-MET metal bonded diamond blades are exceedingly thin, *greatly reducing amount of expensive crystal lost in the cut!* Special blades are supplied for either wafering or dicing insuring maximum efficiency and savings of material!

Fast cutting, smooth finishes, long blade life, utmost reliability . . . you get them all in Felker DI-MET . . . originators of the first commercial diamond abrasive cut-off blades!

Available from your Felker Distributor . . . or write direct.

Above: **FOR DICING TYPE DIT** Available as thin as .006"

Below: **FOR WAFERING TYPE DITR** Available as thin as .015"

FELKER DI-MET SINCE 1924

FELKER MANUFACTURING CO.
Torrance, California

First in Diamond Cut-Off Blades!

CIRCLE 96 READERS SERVICE CARD

FREE - - - Revised IERC Heat-Dissipating Tube Shield Guide!

MORE THAN 1,200 ELECTRON TUBE AND SHIELD COMBINATIONS FOR IMPROVED ELECTRON TUBE RELIABILITY ADDED TO REVISED EDITION. Thousands of original IERC Guides are in daily use everywhere! Newest edition is sent FREE on request. Over 25 pages of easy, thoughtfully referenced listings and fold-out spread of photos designed for fast familiarization and accurate use of the IERC Guide. Latest IERC Heat-dissipating Tube Shields are included—help you select proper shields for new design and retrofitting applications. You won't want to be without this valuable information package if you're designing for maximum equipment reliability—so easy to achieve with IERC Heat-dissipating Electron Tube Shields for effective electron tube cooling and retention under severest shock and vibration environments!

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IERC

International Electronic Research Corporation

145 West Magnolia Boulevard, Burbank, California

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revised edition
IERC
heat-dissipating
tube shield guide
—the practical guide for proper matching of electron tube shield and tube for best cooling, retention, shock protection and maximum tube life.
International Electronic Research Corporation
145 WEST MAGNOLIA BOULEVARD • BURBANK, CALIFORNIA

Heat-dissipating electron tube shields for miniature, subminiature and octal power tubes.

is from −100 F to +200 F or higher, and internal vibration is provided at all temperatures and altitudes. **Circle 328 on Reader Service Card.**

Thermal Relay for missile use

HUGHES PRODUCTS, International Airport Station, Los Angeles 45, Calif., announces a one-time operating, single-pole thermal relay, with a faultless hermetic seal. Small size, positive operation, and convenience of location adjacent to desired components are advantages claimed. Three steps occur within the relay when an electric signal is triggered: (1) Firing effects the release of constrained contact. (2) Contact closes upon a fixed contact point. (3) Switch circuit becomes permanently closed. **Circle 329 on Reader Service Card.**

Transistors germanium type

GENERAL ELECTRIC CO., Syracuse, N. Y., announces a line of four new *pnp* medium speed switching transistors having less than a 20 percent change in h_{FE} and I_{co} after 4,000 hours storage at 100 C. JETEC type-designated 2N394, 2N395, 2N396 and 2N397 they are designed for use in digital computers and other switching applications where highly stable components are required for maximum overall equipment reliability. Bulletin ECG-293 contains characteristic curves and complete ratings. **Circle 330 on Reader Service Card.**

Producers of Guidance Slip Rings for

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by design engineers—because they're
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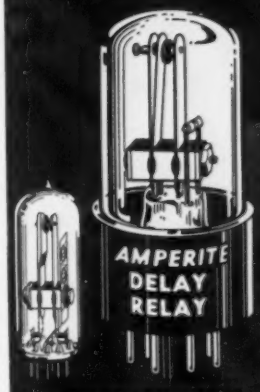
SIMPLEST • HERMETICALLY SEALED



Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived, and—inexpensive!**

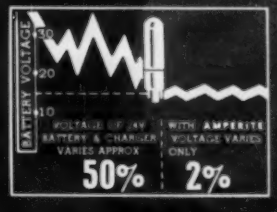
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.** Standard Delays

Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.



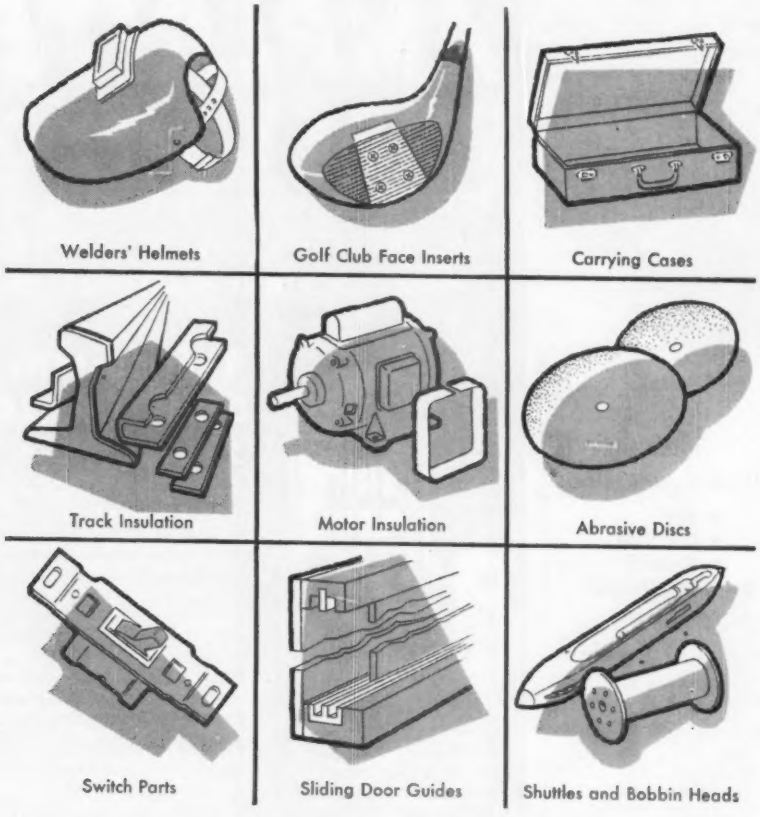
Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.
Telephone: CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 99 READERS SERVICE CARD

A few typical applications of Taylor Vulcanized Fibre



Vulcanized Fibre Is Versatile

The applications of Taylor Vulcanized Fibre are many in number. This is because of its many unusual characteristics. It is a hard, dense material with excellent physical, mechanical and electrical properties. It is tough and resilient; has high resistance to impact, abrasion, wear, organic solvents, oils and gasoline; it can be machined, stamped, punched and formed; it is attractive in appearance, light in weight.

Taylor Vulcanized Fibre is available in a number of different grades, in sheets, rolls and turned rods. Undoubtedly you have an application where the unique properties of vulcanized fibre can be put to work in your product. A Taylor application engineer will be glad to discuss requirements with you and recommend the best grade to fit them. Get the benefit of his advice by contacting TAYLOR FIBRE CO., Norristown 40, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

Literature of

MATERIALS

Radioactivity Absorbers. Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill. A packaged set of radioactivity absorbers, consisting of 24 lead and aluminum disks, is described in a new specification sheet. **Circle 331 on Reader Service Card.**

COMPONENTS

Bobbinless Wire Fixed Resistors. Chicago Telephone Supply Corp., Elkhart, Ind. Two-page data sheet 171 gives new detailed comparative data report on a line of bobbinless precision wire fixed resistors. It describes and illustrates 20 rectangular and tubular resistors including cutaway section picturing the new floating element construction. **Circle 332 on Reader Service Card.**

Capacitors. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn. A four-page brochure illustrates and describes the company's complete line of capacitors. It shows how the manufacturing process of bonding the vitreous enamel dielectric to fine-silver electrodes results in superior performance. **Circle 333 on Reader Service Card.**

Electrolytic Capacitors. Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill. A four-page catalog gives complete data on the type SMT subminiature tubular electrolytic capacitors including voltage range and temperature ranges. Listed in simple chart form, the information is easy to use for reference. **Circle 334 on Reader Service Card.**

Semiconductor Products. Texas Instruments, Inc., P.O. Box 312, Dallas, Tex. A new six-page folder gives complete technical specifications for a wide line of semiconductor products. Included are silicon and germanium transistors, silicon diodes and rectifiers, precision film resistors, solid tantalum

the Week

capacitors, Sensistor silicon resistors, and diffused base germanium transistors. **Circle 335 on Reader Service Card.**

EQUIPMENT

Control Reactor Manual. Chicago Magnetic Control, 1616 N. Damen Ave., Chicago 47, Ill. A 32-page manual illustrates and describes 48 job-rated control reactors. Sensitivity range, circuit design and control/output ratios are covered. **Circle 336 on Reader Service Card.**

Metal Fabricated Products. Electronics Division, Van Norman Industries, Inc., 186 Granite St., Manchester, N. H. A 20-page catalog of metal fabricated products contains the newly designed Insuline line of electronic housings. **Circle 337 on Reader Service Card.**

Power Units. Syntron Co., Lexington Ave., Homer City, Pa., has published a new selenium rectifier a-c to d-c power unit catalog. Complete data and specifications are contained in the profusely illustrated 10-page booklet. **Circle 338 on Reader Service Card.**

Tubeless D-C Power Supply. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn., has available a technical data sheet describing their model MA28-125 tubeless d-c power supply. The unit discussed has an output of 0-125 amperes over a regulated voltage range continuously variable from 18 to 36 v d-c. **Circle 339 on Reader Service Card.**

FACILITIES

Resistor Testing. Mepco, Inc., Morristown, N. J., is offering an illustrated 20-page brochure, entitled "Factual Resistor Reliability," which describes in detail the nondestructive conditioning and testing procedures used on the company's line of high reliability precision resistors. **Circle 340 on Reader Service Card.**

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Electro-Pulse
PRECISION PULSE GENERATORS

- 10 CPS to 100 KC
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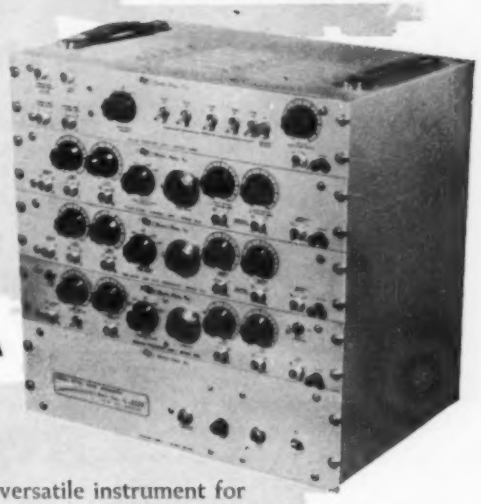
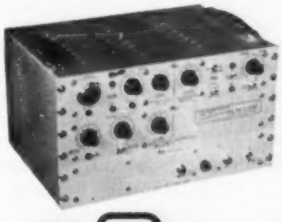


Model 2120A

An extremely versatile instrument for the generation of accurately controlled test pulses—also provides gate pulses, neg. triangles, and five sync. pulses in each cycle. Ideally suited for: Computer Development...Radar Test...Fuse and Relay Research...Pulse Modulation...Transient Response Studies... General Pulse Circuit Development.

• 10 CPS to 100 KC Rep. Rate • 0 to 10,000 μs Delay • .1 to 1,000 μs Pulse Width • 80 V Amplitude (open circuit) • 93 Ohms Internal Impedance • .02 μs Rise Time • Twin Pulse or Advanced Pulse Connection



Write for Complete Data: Our Bulletin 2120A/1

The Model 2120A Pulse Generator is one of a series of Electro-Pulse precision instruments. Others: Analog and Digital Time Delay Generators, Pulse Oscillators, Magnetic Core Testing Equipment, and Megacycle Pulse Generators.

Model 1310A LONG TIME DELAY GENERATOR

Representatives in Major Cities

Electro-Pulse, Inc.
11861 TEALE STREET, CULVER CITY, CALIFORNIA
Telephones: EXmont 8-6764 and TExas 0-8006

Ling Acquires Sixth Firm

ACQUISITION of United Electronics Co. of Newark, N. J., makes the sixth wholly owned subsidiary taken on by Ling Electronics, Inc., Culver City, Calif., in the past two years.

Announced purchase price was $750,000 paid in cash and 65,000 shares of common stock of Ling. In return, Ling acquired all of United's common stock.

Top management of two firms gathered following completion of the transaction are (above, l to r): James J. Ling, chairman, Ling board of directors; John R. Beers, United vice-president in charge of research and engineering; Charles A. Rice, president of United, and Cameron G. Pierce, president of Ling.

United Electronics is a 23-year-old company involved in design of high-energy, special-purpose thermionic tubes and fixed and variable ceramic vacuum capacitors. Its proprietary products are used in radar, physiotherapy, radio frequency power, radio transmission and ultrasonic instrumentation applications.

Ling Electronics is a pioneer in the design and manufacturing of high-power, electronically driven systems for random, complex and sine wave vibration testing. These systems include high-power vibration generators, systems consoles and other specialized equipment necessary to duplicate in laboratory testing the intense vibrations encountered by jet aircraft, missiles and rockets in flight.

The parent company recently moved from its former Los Angeles location into a large new manufacturing plant and offices in Culver City. The plant covers 38,400 sq ft of floor space and represents an investment in excess of $500,000. Besides providing increased floor space for assembly line and specialized manufacturing operations, the new headquarters houses engineering, stock room and warehouse facilities, research laboratories, and offices for engineering and administrative personnel.

Maryland Firm Expands

TO PROVIDE additional space for its manufacturing activity, Aircraft Armaments, Inc., Cockeysville, Md., has leased a newly constructed building in Towson. Designated as Annex F, the new building is the sixth annex acquired by the organization since moving into its main plant in September 1954.

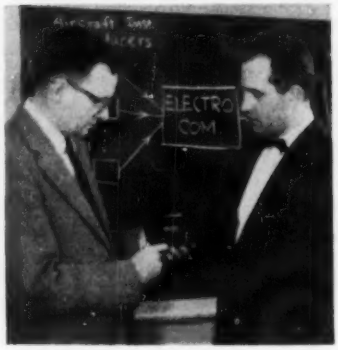
Brauer Joins Fansteel

HOWARD H. Brauer has joined Fansteel Metallurgical Corp. as staff assistant to Glen Ramsey, v-p and general manager of the company's rectifier-capacitor division. His principal activities are systems and procedures in accounting, production controls, scheduling and marketing, particularly the mechanization of these procedures with punched cards.

Brauer comes to Fansteel after 10 years at Bell & Howell Co. as chief electronics engineer.

U. S. Edcor Moves To Phoenix

THE ENTIRE administrative and manufacturing facility of U.S. Electronics Development Corp. recently moved from Glendale, Calif., to Phoenix, Ariz. The new 35,000 sq ft plant is devoted entirely to the research engineering and production of electronic capacitors for commercial, industrial and military use.



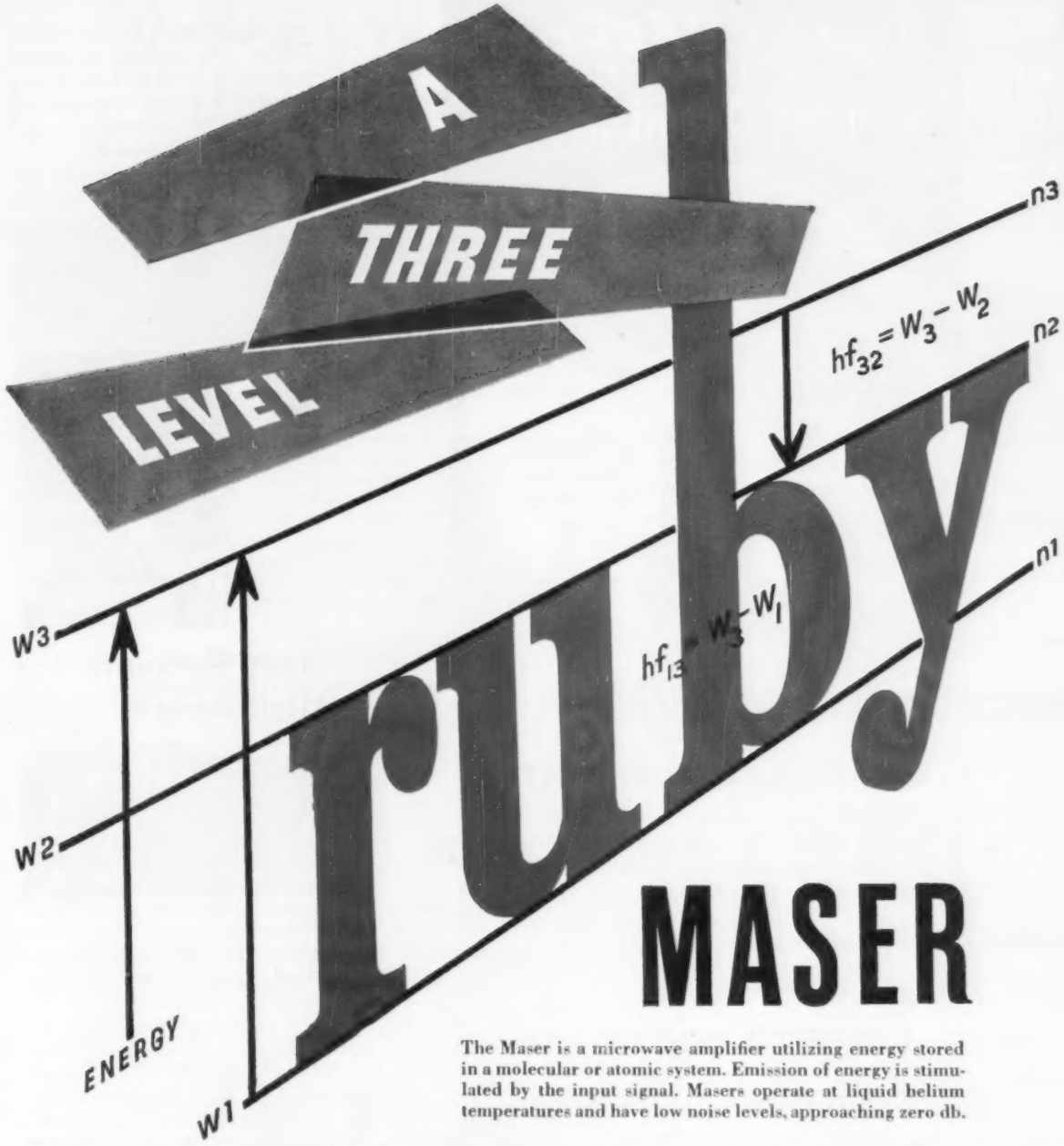
General Devices Names Director

WALTER C. JOHNSON (pictured, left) chief consultant of General Devices, Inc., Princeton, N. J., is appointed a director of the company, as announced by its president, John Brinster (right).

General Devices specializes in multichannel instrumentation devices, creating, engineering and manufacturing components and systems for scientific, military and industrial uses.

Collins Division Reorganizes

THE Texas Division of Collins Radio Co. has consolidated research, development, sales and manufacturing activities to concen-



The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have low noise levels, approaching zero db.

Recently, a university research laboratory† used LINDE single crystal synthetic ruby (Al_2O_3 with Cr_2O_3 additive) in a three-level solid state Maser. The ruby crystal was placed in the Maser's tuned cavity and a magnetic field of 4200 gauss was applied. To bring electrons from a ground state into a permissible higher energy level, a pumping frequency of 24 kMc was used and the Maser amplified signals at 9.3 kMc.

LINDE supplies other crystals, including rutile, spinel, and sapphire. (Al_2O_3). Sapphire is used in infrared optical systems, windows for higher power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C., is hard, inert, nonporous, and can be sealed to metals and glasses. Sapphire is available in the shape of domes, windows to 4½ inches in diameter, rods and special configurations.

For more information, write Crystal Products Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

†*Maser Action in Ruby*, by G. Makhov, C. Kikuchi, J. Lambe, and R. W. Terhune, "Physical Review," Vol. 109, No. 4, p. 1399, Feb. 15, 1958.

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DE-SOLDERING KIT

#270 Popular lightweight pencil handle with 5 assorted tips for every de-soldering operation. Slotted tip that melts solder and straightens bent or folded tube tabs. Bar tip for straight line de-soldering. 3 different size cup tips that de-solder tube tabs and center pin in one simple operation. In goldtone metal case. List $5.95 each.

COME TO BOOTH 228

See this new de-soldering technique demonstrated ...also newest tips for soldering subminiature components.

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Ungar Electric Tools, Inc.

4101 Redwood Avenue, Los Angeles 66, California

trate on microwave communication systems. The emphasis on microwave specialization has been accomplished by divisional reorganization, selection of key personnel and addition of microwave specialists.

The company's backlog in the microwave business is approximately $9 million, and includes orders from the CAA for its national air traffic control system for the jet age aircraft.

Navy Presents High Award

THE Navy Certificate of Merit, one of its highest honors, was recently awarded the Cooke Engineering Co., Alexandria, Va. Nelson M. Cooke (pictured, right), company president, accepted the award from Rear Admiral A. G. Mumma, acting for the Secretary of the Navy.

Specifically, the award was granted for the successful accomplishment of the emergency "turnkey" project of effecting the systems design, planning, provisioning, installing, "checking-out", and turning over to the Navy an extensive radio communications facility at Londonderry, Northern Ireland. The entire project was completed in six months.

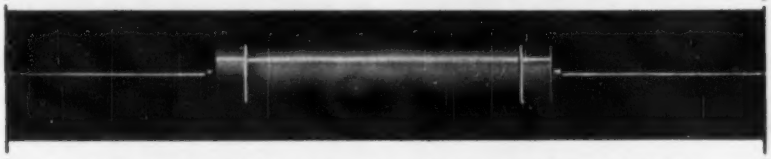
Hull Elected EIA President

AT ITS RECENT 34th Annual Convention in Chicago, the Electronic Industries Association elected David R. Hull president.

A vice president of defense programs of the Raytheon Mfg. Co., Waltham, Mass., Hull succeeds W. R. G. Baker, who retired last

WELWYN

High Stability Carbon Resistors



Uniformity and reliability are essential criteria in the selection of critical components. Availability is another. And these relate directly to the experience and facilities of the manufacturer.

Four full-time Welwyn Plants in Britain and in Canada are today supplying a steady flow of precision resistors to meet an ever-growing American demand. With sales engineering and service facilities operating out of Ohio, these Welwyn users in the U.S. are enjoying prompt, efficient and reliable handling of all their quality resistor requirements.

The Welwyn organization has been devoted to the study and development of carbon film techniques for nearly a quarter of a century. The value of this experience is being constantly demonstrated in the superior performance and dependability of Welwyn Carbon Resistors in critical applications.

For complete information, write to:

WELWYN INTERNATIONAL INC.

3355 Edgecliff Terrace, Cleveland 11, Ohio, or phone WInton 1-1333

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Cockeysville, Maryland

AAINC. MODEL 2830

MISS-DISTANCE MEASURING SYSTEM

AN/USQ-11

– developed by Naval Ordnance Laboratory, Silver Spring, Maryland
– product-engineered and produced by Aircraft Armaments, Inc.

OUTSTANDING FEATURES: Meets MIL-E-5272A 5400B, 16400 -- provides data in 2 min. -- requires transponder in drone only -- measures salvo firings -- determines miss on multiple targets. Target equipment (less power supply) under 2 lbs. Accuracy confirmed by field tests.

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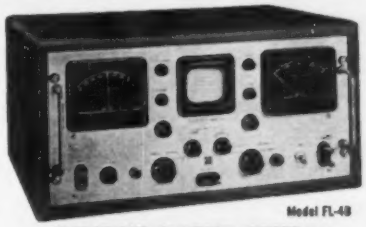
SYNONYMOUS d&r LTD. FLUTTER METERS

For the most complete line of Flutter Meters, there is only one source – d & r LTD. From the meters used in simple maintenance test equipment to the most complex standardization and analysis equipment for missile flight systems and telemetering systems – we make them all.



Model FL-4B

WIDEBAND FLUTTER METERS

MODEL FL-3D FLUTTER AND WOW METER

Features
A convenient instrument of moderate cost for use in field maintenance of music-system tape recorders and reproducers, and phonograph turntables.

Specifications
Carrier frequency – 3000 cps, stabilized oscillator
Bandwidth – within 3 db to 250 cps modulation
Bandwidth Selection – 0.5 to 6 cps, 6 to 250 cps, 0.5 to 250 cps
Scale Ranges – 2% and 0.5% full scale rms

Price: $225.00

MODEL FL-4B WIDEBAND FLUTTER METER

Features
A very sensitive broadband instrument for laboratory use in the precise measurement of small amounts of flutter with components up to 5000 cps. Most frequently used in telemetering and data reduction systems.

Specifications
Carrier Frequency – 14,500 cps, crystal controlled
Bandwidth – D-c to 5000 cps within 6 db
Bandwidth Selection – Full range above, 0.5 to 30 cps, 30 to 300 cps, 300 to 5000 cps.
Scale Ranges – 0.2%, 0.6% and 2.0% rms full scale
Drift Meter – ± 2.0% frequency change d.c. to 4 cps
Display – 3-inch flat-face oscilloscope for flutter analysis

Price: $965.00 rack mounted, $1000.00 in cabinet

MODEL FL-5A LABORATORY STANDARD FLUTTER METER

Features
An extremely stable (temperature controlled discriminator) instrument with great sensitivity and extended bandwidth for laboratory work in connection with precision instrumentation data recorders. Galvanometer outputs provided.

Specifications
Carrier Frequencies – 40 kc. and 70 kc., crystal controlled
Bandwidth – D.c. to 10 kc. with 70-kc. carrier to 4 kc. with 40 kc. carrier
Indicating Instruments – Level Meter, and ±2% Drift Meter
Output Signals – Scope, two galvanometer outputs
Sensitivity – 0.05%, 0.2% and 2.0% selectable
Drift – On d-c galvo. output, less than 10 parts per million in ½ hour

Price: $3450.00 rack mounted

MODEL FL-6A BROADCAST FLUTTER METER

Features
An instrument designed for accurate measurement and analysis of flutter and wow in high-quality audio tape recorders.

Specifications
Carrier Frequency – 8000 cps., stabilized oscillator
Bandwidth – D.c. to 1200 cps.
Bandwidth Selection – Full range, 0.5 to 30, 30 to 300, 300 to 1200 cps.
Scale Ranges – 0.2%, 0.6%, and 2.0% rms full scale
Display – 3-inch oscilloscope for waveform observation

Price: $845.00 rack mounted, $880.00 in cabinet

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NEWS ABOUT
BENDIX SHAFT ENCODERS

Photo-Electric Sensor Types Added to Line

The Bendix® "Supermarket" for precision components has long served your analog-digital converter needs with miniature, brush slip-ring shaft encoders featuring extremely high resolution. Now, with the addition of new photo-electric sensor types, the Bendix shaft encoder line makes Bendix extra quality available for even broader applications.

With these new photo-electric sensor units, you enjoy the important advantages of higher operating speeds, lower operating torque requirements, longer life, and finer resolution in relation to physical size.

The specification table below is the best evidence we know that your shaft encoder needs find their most efficient answer at the Bendix Supermarket.

District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C. Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

BENDIX OFFERS WIDE CHOICE TO FIT YOUR EXACT SHAFT ENCODER NEEDS

TYPE NO.	GS-7-A1	GS-8-A1	GS-5-A1	GS-3-A1	GS-4-A1	GS-E-A1
OUTPUT	9 DIGIT GRAY	13 DIGIT BINARY	8 DIGIT GRAY	9 DIGIT BINARY DECIMAL (GRAY)	7 DIGIT BINARY	13 DIGIT GRAY
STYLE	PHOTO-ELECTRIC	DOUBLE BRUSH	BRUSH	BRUSH	DOUBLE BRUSH	BRUSH
RESOLUTION	1 PART IN 512	1 PART IN 8192	1 PART IN 256	1 PART IN 198	1 PART IN 128	1 PART IN 8192
MILLI-AMPS/DIGIT	.075 (MAX.)	10 (MAX.)	10 (MAX.)	15 (MAX.)	10 (MAX.)	10 (MAX.)
CONT. SPEED (RPM)	HIGH SPEED†	150 (MAX.)	150 (MAX.)	150 (MAX.)	150 (MAX.)	50 (MAX.)
OPERATING TORQUE	.05 OZ-IN. (MAX.)	.50 OZ-IN. (MAX.)	.20 OZ-IN. (MAX.)	.22 OZ-IN. (MAX.)	.31 OZ-IN. (MAX.)	.40 OZ-IN. (MAX.)
CASE DIAMETER	1.191 INCH	1.411 INCH	.937 INCH	.937 INCH	.937 INCH	2.50 INCH

†RPM DETERMINED BY APPLICATION

*You Can't Beat The Bendix Supermarket.

Eclipse-Pioneer Division

Bendix
AVIATION CORPORATION

Teterboro, N. J.

year as vice president of General Electric Co. and this year concluded his second term as EIA president.

Scal Appointed General Mgr.

ROBERT SCAL (picture), vice president and chief engineer of R/S Electronics Corp., Palo Alto, Calif., a subsidiary of Regan Industries, Inc., has been named to assume the duties of general manager of the subsidiary.

R/S Electronics manufactures electronic equipment for military and industrial uses, including a full line of i-f amplifiers for missile, radar, and aircraft installation.

Scal joined the Regan subsidiary in 1954 as chief engineer, after serving for seven years as chief of the Radar Miniaturization Unit of the Electronics Div., National Bureau of Standards.

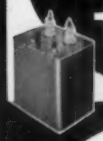
FEC Transfers Myron Bakst

APPOINTMENT of Myron Bakst as project manager for the White Alice integrated civilian-military communications system in Alaska has been announced by F. H. Lanahan, president of Federal Electric Corp., Paramus, N. J.

FEC, service subsidiary of IT&T Corp., operates and maintains the system under a contract with the Air Force.

Bakst was transferred to the system from the Distant Early Warning (DEW) Line, also operated

WIDEST RANGE OF PRECISION FILM CAPACITORS FROM fci



The widest range of time-tested stabilized precision capacitors available with polystyrene, polyethylene, teflon, and mylar plastic film dielectrics. Designed for critical applications. FCI Capacitors have high insulation resistance, low power factor and dielectric absorption, and are available in a wide variety of capacitance values, tolerances, casings and sizes. Write for FREE CATALOG showing complete line.

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Count on SYSTRON RDB COUNTER with in-line readout

MODEL 1043

MEASURES
★ RDB Channels 1-18
★ RPM
★ Mass Flow Rate
★ Frequencies
★ 1 to 100,000 Periods

FREQUENCY RANGE ...5 CPS to 100 KC
ACCURACY ..± 1 count, ± 1 part in 10^5
READOUT ..... Nixie, to 99,999
SENSITIVITY .....5 Millivolts rms
TIME BASES:
RDB .....1/5 second
CPS ..... 1 & 10 seconds
RATE .... Selectable 0.1ms increments to 10 secs.
PERIOD 1 to 100,000 cycles of input
PRICE.....$1,550
F.O.B. Concord

SYSTRON CORPORATION

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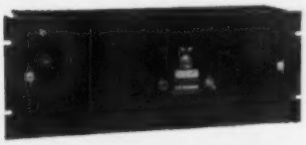
CIRCLE 209 READERS SERVICE CARD

THE BEST IN STATION RECEIVERS

Aerocom's Model 77 single-channel H.F. crystal-controlled receiver was designed and built to meet your needs.



A high-performance, rack-mounted, rugged receiver, designed for reception of A1, F1 or A3 signals. Frequency range is from 2 MCS to 24 MCS, using permanently mounted R.F. coils which are selected by rotary switch. *(No plug-in coils).* Can be operated continuously in any climate from hot and humid to very cold. *Crystal* band-pass filter used in I.F. amplifier. 6 KC width normally supplied for A3 and 1.8 KC width normally supplied for FSK.

Two Model 77 receivers can be used in a space-diversity system by using Aerocom's Model DRC diversity combining unit.

Power supply 115 Volts or 230 Volts 40/60 Cycles single phase. All controls on front panel, each with switch to permit remote operation.

Removable front cover permits access to all parts for checking without removing receiver from rack.

Miniature tubes extend from rear, providing maximum cooling.

AERO COM

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Miami 33, Florida

CIRCLE 210 READERS SERVICE CARD

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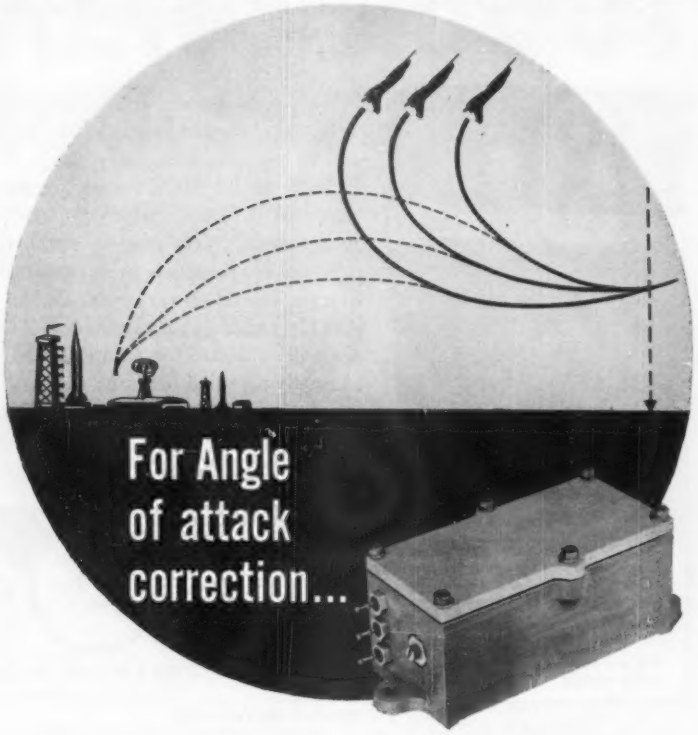

FAIRCHILD ACCELEROMETERS

FAIRCHILD FEATURES — Fairchild Linear Accelerometers are miniature in size, light weight, and have high sensitivity and resolution.

Three basic designs are offered. The TA-100 is an economical pendulous accelerometer with torsion bar suspension and pot pick-off. The TA-200 is an axial design with coil spring restraint and pot pick-off. The TA-400 is a floated pendulous accelerometer using a torsion bar with jewel bearing suspension and an a.c. type pick-off.

OTHER OUTSTANDING FEATURES

1. Potentiometer or AC pick-offs
2. Linear or non-linear pot outputs
3. Low cross-talk
4. Low temperature error
5. High sensitivity

TYPICAL SPECIFICATIONS

Model	TA-100 (low natural frequency)	TA-200 (Low Cross talk)	TA-400 (Low cross-talk & high accuracy)
Standard pick-off	potentiometer	potentiometer	A.C. reluctance
G range	±1 to ±30g	±1 to ±100g	±½ to ±10g
Natural Frequency	5-40 cps	7-50 cps	8-80 cps
Damping factor	.7 @ 25°C	.7 @ 25°C	.7 @ 25°C
Overall accuracy	1.5%	1.5%	better than 1%

The TA-100 and TA-200 can be supplied with A.C. type or Fairchild's Nobl-Ohm infinite resolution Film Pot pick-offs on special order.

For information write to Dept. 21-E

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COMPONENTS DIVISION

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Potentiometers • Gyros • Pressure Transducers • Accelerometers

and maintained by FEC, where he was assistant project manager. The DEW Line is a chain of radar stations extending 3,500 miles from Point Barrow, Alaska, to Baffin Island.

Camden Firm Elects V-P

In Camden, N. J., Magnetic Metals Co., manufacturers of electromagnetic core products for the transformer industry, has elected Donald O. Schwennsen (picture) vice-president. With the company since 1956, his new duties will include both engineering and managerial responsibilities.

Organize New Company

The Adams-Russell Co., Inc., Cambridge, Mass., was recently formed by Gerald J. Adams, Lindsay Russell and Oliver H. Straus.

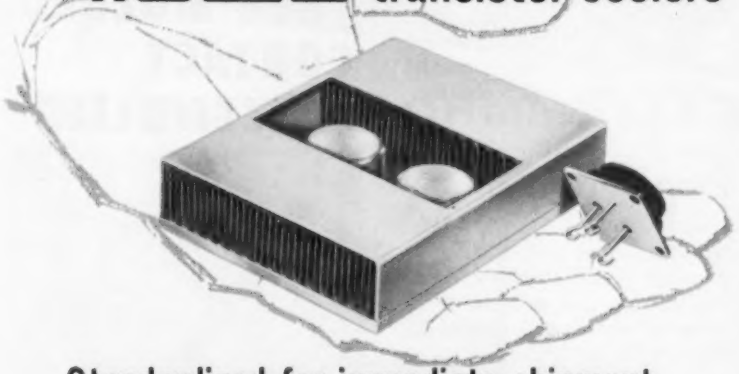
Adams has been a project manager and group head at Hycon Eastern, Inc. of Cambridge for the last three years. For the preceding eight years he was senior engineer at Alford Consulting Engineers of Boston.

Russell was formerly a project engineer at Hycon Eastern, and was also a project engineer at Alford Consulting Engineers from 1951 to 1956.

Straus was also at Hycon Eastern, Inc. as a vice president. Prior to

Announcing . . .

Modine transistor coolers



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These compact, lightweight aluminum units prevent thermal runaway in electronic circuits . . . hold transistor junction temperature safely within design limits. Heat is conducted through the base mounting plate and is dissipated by cooling air passing through the fins.

Modine Bulletin ID-158 contains performance data and application information on these efficient coolers. For full details on standard and custom-built models, write Electronic Cooling Dept., Modine Manufacturing Co., 1602 DeKoven Avenue, Racine, Wisconsin.

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* Dupont trademark

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Please write to: Mr. F. H. Stevenson, Engineering Personnel, North American Aviation, Los Angeles 45, California.

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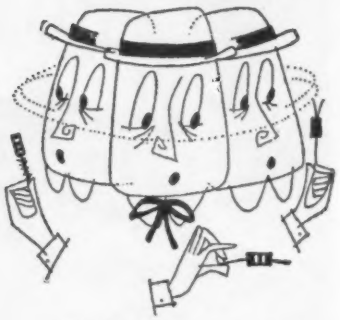

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that he was a director of the company and assistant to the director of engineering at National Co., Malden, Mass.

The new firm is engaged in electronics manufacturing, research and development, and consulting.

Plant Briefs

Syncro Corp. of Oxford, Mich., manufacturer of power tools, has expanded into the field of capacitors and LC coils with the building of a new plant in Hicksville, Ohio.

Aerolab Development Co., Pasadena, Calif., recently acquired a new building with 15,000 sq ft of floor space adjacent to its main plant. New facilities will be used for design and manufacture of high altitude research missiles.

Electronics Corp. of America, Cambridge, Mass., has established an affiliate in Rio Piedras, Puerto Rico. New firm, Electronics Corp. Pan America, will manufacture industrial electronic controls for the transportation industry.

News of Reps

Four newly appointed reps will handle electronic test equipment for Telectronics Laboratory, Inc., Westbury, N. Y. Reps and their territories are:

Broger Instrument Sales Co. for New England; **W. K. Geist Co.** for southern California, Arizona and New Mexico; **George F. Landfear Enterprises** for New Jersey and metropolitan New York; and **Ohio Instrument Co.** for Ohio, Kentucky, West Virginia and western Pennsylvania.

American Microphone Mfg. Co., a division of GC-Textron, Inc., names two new reps. The **Robert W. Peters Co.** will cover Ohio, West Virginia and western Pennsylvania. **Stan Cluphf & Associates** are appointed for Colorado, southern Idaho, eastern Montana, New Mexico, Utah, Wyoming, and El Paso County, Texas.

announcing

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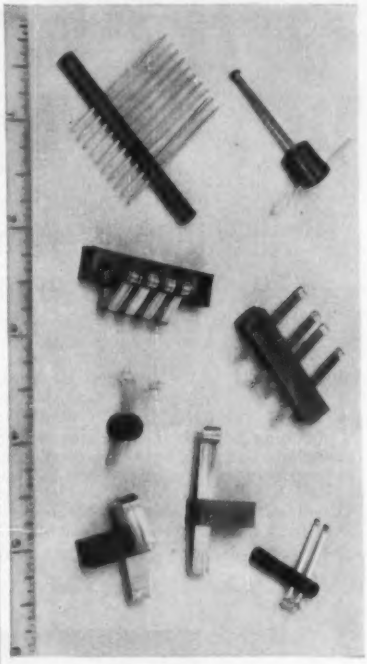

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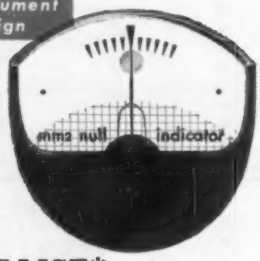

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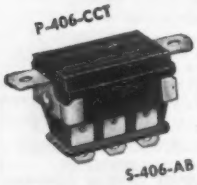

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NEW BOOKS

Electronic Designers' Handbook

By R. W. LANDEE, D. C. DAVIS, AND A. P. ALBRECHT.

McGraw-Hill Book Co., Inc., New York, 1957, 1,048 p, $16.50.

THE authors of this addition to McGraw-Hill's handbook library have directed their efforts to students and practicing engineers in the electronic field.

The book is divided into 23 sections and in size, format and general content is very similar to F. E. Terman's "Radio Engineers' Handbook". The first seven sections of the new handbook cover the subjects of general design, data, vacuum tubes and transistors, voltage amplifiers, power amplifiers, modulation, oscillators and receivers. The new material covers transistors, design problems arising from the need for circuits to handle pulses, suppressed-carrier and single-side-band generation, backward-wave and phase-shift oscillator circuits and the more sophisticated band-pass circuits involving flat-staggered tuning.

Noise—In the section on receivers, the discussion of noise is more extensive than that found in many textbooks. In this same section there is also an excellent discussion on tube and crystal mixers together with illustrative examples to bring out the important points.

The following five sections on multivibrators, variable delay circuits, trigger circuits, sawtooth generators, clippers, limiters and clamps, point up the tremendous growth in pulse and digital techniques.

Of the sections on inductively coupled circuits, transformers and chokes, power supplies, filters, attenuators and equalizers, the section on transformers and chokes is notable in that it presents a comparatively complete treatment of the design of low-power iron-core transformers and chokes. The section on filters presents graphical performance data for constant-k and m-derived filter sections having dissipation.

Principles of feedback and com-

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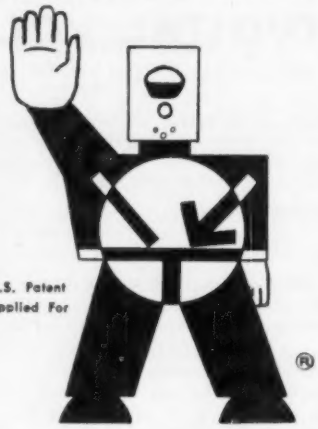

*U.S. Patent Applied For

BOOTH 919 WESCON

Power Designs inc.
89-35 130th STREET RICHMOND HILL 18, N. Y.

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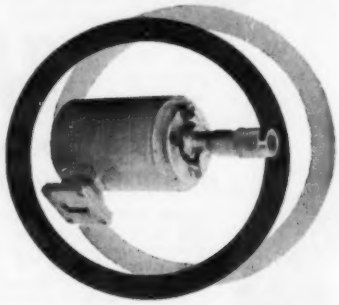
D-B broad band gas-filled cavity wavemeters



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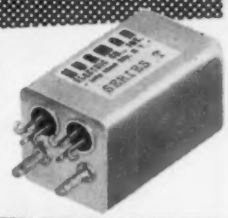

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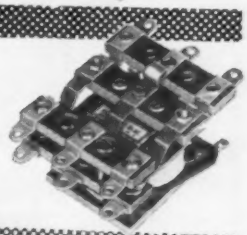
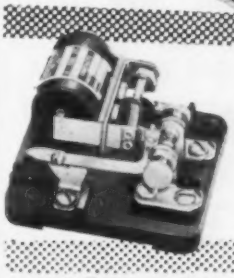
Series 26





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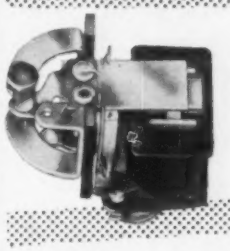

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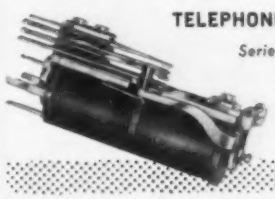

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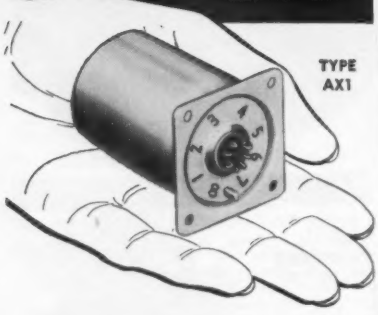

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h. 3% accuracy under normal test conditions.

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puter and servomechanism techniques are discussed in two excellent sections which total nearly 10 percent of the book, again illustrating the dramatic expansion of the horizons of the electronic designer over the short span of a decade and a half.

The sections on transmission lines and antennas illustrate the growing use of the Smith chart and the increasing emphasis on the microwave frequencies.

Network Theory—The two final sections on waveform analysis and network analysis include fundamentals of statistical and probability theory, graphical methods as an aid in the determination of inverse Laplace transforms, the analysis of complex waveforms and what amounts to a short course in network theory.

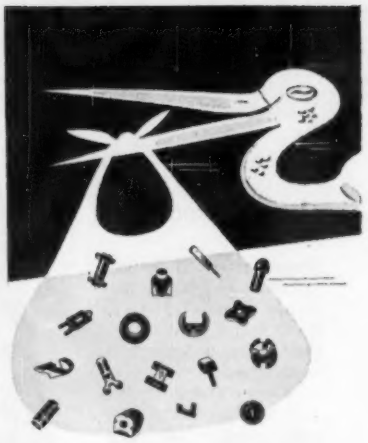
The usual mathematical tables are missing but should be of no concern to the average user who probably has the necessary tables duplicated many times even if his technical library is a modest one.

Designs Illustrated—In the preface the authors have stated that it has been their opinion that handbooks often have limited value since the presentation is frequently so concise that the material presented has little value unless the reader has had previous experience with the subject. Consequently an attempt has been made to overcome this limitation by making the text as lucid as possible and by including design examples which illustrate the application of the material to specific design problems.

It is the opinion of this reviewer that the authors have successfully met their goal and have contributed a very useful tool for the electronic designer. This book deserves a place on every reference shelf.—JOHN BOSE, *Columbia University, Electronics Research Lab., New York, N. Y.*

THUMBNAIL REVIEWS

Streamlined Lens-Radomes (PB 131041). By A. F. Kay, OTS, U. S. Dept. of Commerce, Washington, D. C., 1956, 49 p, $1.25. Design technique for variable-refractive-index lenses combined with a



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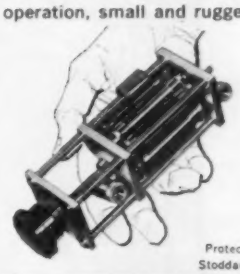

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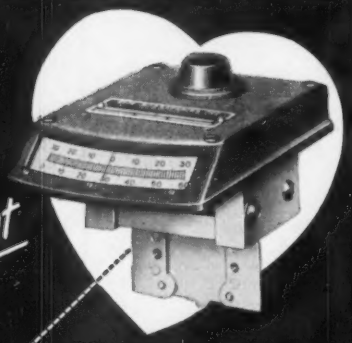

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Radio Control Mechanisms. By Raymond F. Stock, Data Publications Ltd., 57 Maida Vale, London W 9, England, 64 p, 4s 6. Compilation of articles from **The Radio Constructor** on electromechanical control mechanisms for model boats, aircraft, etc.

Uber die Anwendung von Ferriten zur Amplitudenmodulation von Mikrowellen. By Miguel Santesmases, Verlag Leemann, Zurich, Switzerland, 1957. Use of ferrites in waveguides and their application to amplitude modulation using Faraday effect and resonance absorption.

One Hundred Electronic Circuits—Vol. 1. By M. H. Aronson and C. F. Kezer, Instruments Publishing Co., Inc., Pittsburgh, Pa., 167 p, 1957. Simple circuits with detailed specifications and all component values cover a wide variety of applications including power supplies, oscillators, pulse and signal generators, etc.

Soviet Education for Science and Technology. By Alexander G. Korol, Technology Press and John Wiley & Sons, Inc., New York, 1957, 513 p, $8.50. General outline of the entire Soviet educational system from elementary to graduate schools, with detailed illustrations of training in physics and mechanical engineering.

The Elements of Physics. By A. Smith and J. Cooper, McGraw-Hill Book Co., Inc., New York, 1957, 669 p, $7.50. This sixth edition has a rewritten section on electricity and magnetism. In addition, the number of problems has been approximately doubled. Emphasis continues to be on the practical application of physics to everyday living.

A Guide to Effective Report Writing. Industrial Relation News, 230 W 41 St., New York, N. Y., 1957, 30 p, $1.50 (paper). This concise publication first acquaints the reader with different types and forms of reports, then gives him advice on illustrations, typing, punctuation, layout and other practical aspects of turning out a report.

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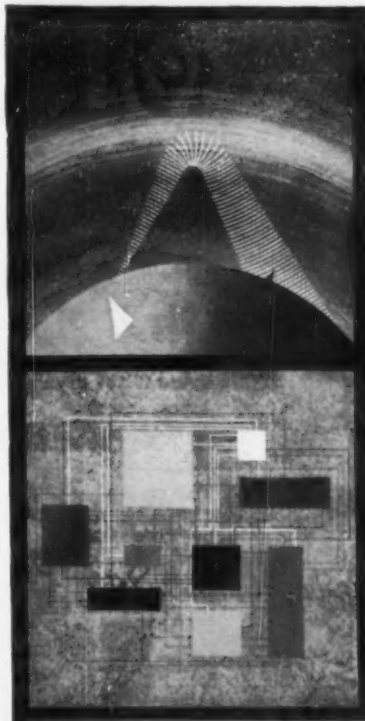

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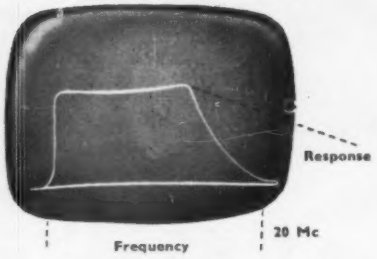

MARCONI 20-Mc SWEEP GENERATOR TYPE 1099

Abridged Specification

Frequency Swept Output: Frequency Range: Lower limit 100 kc, Upper limit 20 Mc. Output level: Continuously variable from 0.3 to 3 volts. Output Impedance: 75Ω. *Time Base:* Repetition Rate: 50 to 60 cps. Output for c.r.o. X deflection: 250 volts. *Frequency Markers:* At 1 Mc intervals; every fifth pip distinctive and crystal controlled. Tubes: 6AK5, 6BH6, 5763, 6BJ6, 6CD6G, 6BE6, 12AT7, 12AU7, 6C4, 5V4G, OA2, 5651.

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COMMENT

And More Symbols

Comments about the conflict between symbols for transistor and gated rectifier (June 20, p 158 and Aug. 1, p 159) raise a question of great concern to the circuit designer, since circuit diagrams must be clearly understood in order to fulfill their purpose.

The rapid pace of progress in this field leaves the engineer short of symbols, short of standards, and short of breath in keeping up with the advance of technology.

The fountainhead of information in this matter is made up of the Institute of Radio Engineers, American Institute of Electrical Engineers, American Standards Association, and the office of standardization of the Department of Defense. All these groups have cooperated to prepare the military standards known as "Mil Specs." The military standard for graphical symbols is MIL-STD-15A. It is mandatory for all government contracts.

This standard shows this symbol for a tetrode transistor

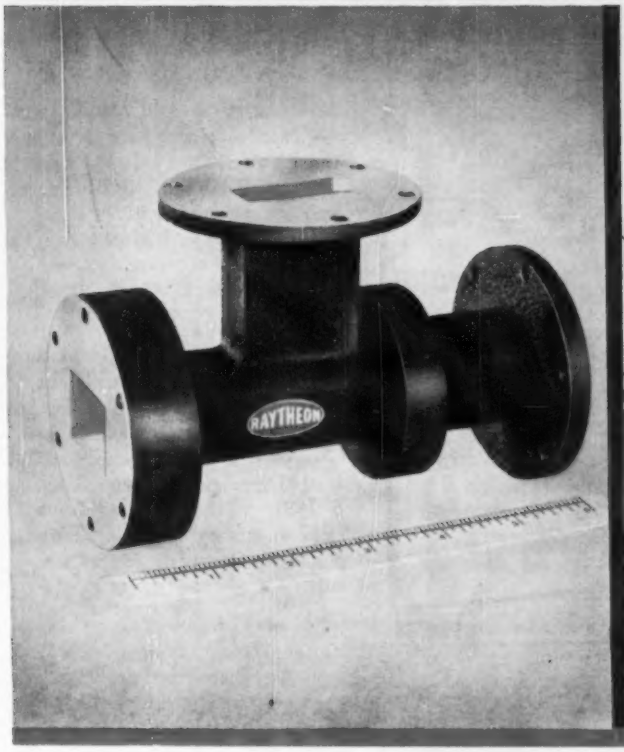
and this for a pentode transistor.

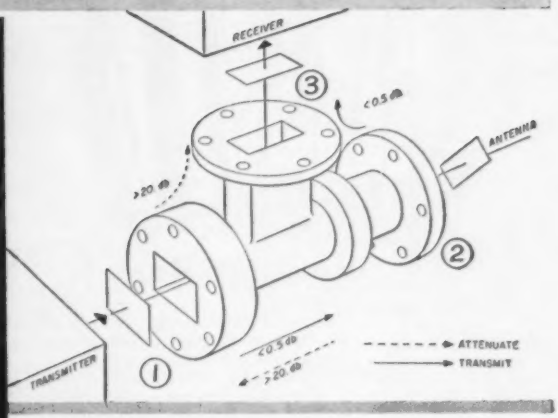
Obviously the gated rectifier symbols used by ELECTRONICS, as well as that proposed by Messrs. Frenzel and Gutzwiller (Comment, June 20) infringe on the ones already approved by MIL-STD-15A for special transistors.

Mil specs have not caught up yet with the gated rectifier, and no official symbol is available now for this device.

Whatever modification is made to the standard rectifier symbol in order to represent a control gate terminal, it should not be made to resemble a transistor. A transistor is a current amplifier, a rectifier is not; and their symbols should re-

Recent Raytheon achievements in Microwave





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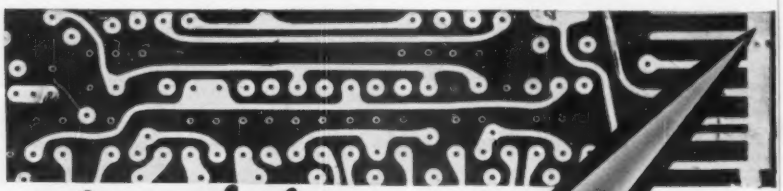

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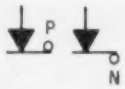
flect the wide difference.

My suggestion is a symbol along these lines:



that is, the standard rectifier symbol extended to include the standard for a terminal, which is a small circle, the P or N to signify the kind of gate terminal.

JOHN J. RIVERA
FEDERAL TELECOMMUNICATION LABORATORIES
BELLEVILLE, N. J.

Reader Rivera's letter came into our office before we had a chance to print the reasoned and definitive discussion of the problem by S. K. Ghandhi of IRE's semiconductor symbol group (Comment, Aug. 1, p 159). Reader Ghandhi made clear in his letter the philosophy of IRE in setting up symbol standards:

"Symbol structure must be a logical extension of a well-accepted symbol and must be capable of extension to new devices as the state of the art progresses. A symbol should not be based on theory of operation . . . theories have a habit of being improved continuously. . . . A symbol should indicate the physical properties where possible without complication."

The symbols suggested by Mr. Rivera in the last pragraph of his letter seem to be based more on theory than on physical properties.

An Error in Authorship

My name appeared as one of the co-authors of the article "New Intermetallics Offer Wide Infrared Response" (July 4, p 48). Since I did not actually make any contribution to this article, I would appreciate a notice deleting my name as author.

Thank you very much for rectifying this error.

ALAN J. STRAUSS
CHICAGO MIDWAY LABORATORIES
CHICAGO, ILL.

Reader Strauss' valuable work in intermetallics apparently got in our way.

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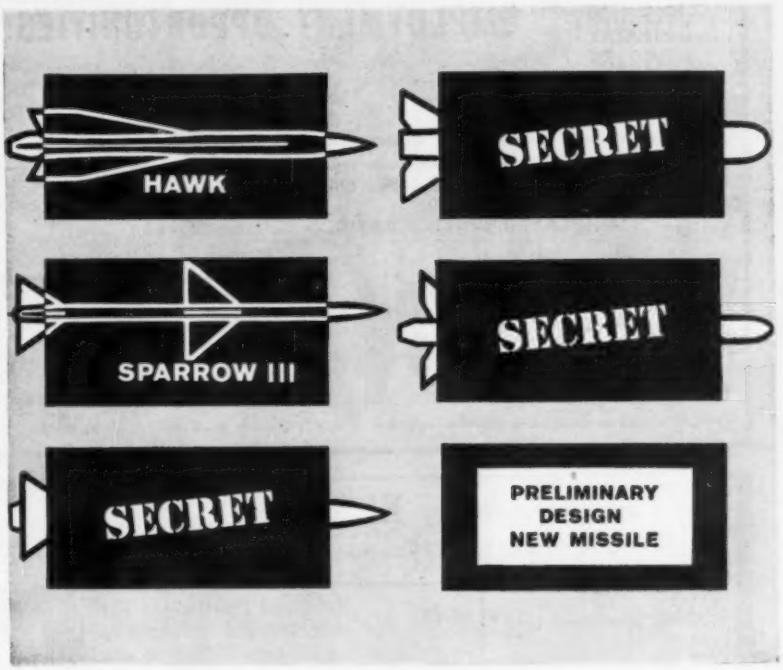

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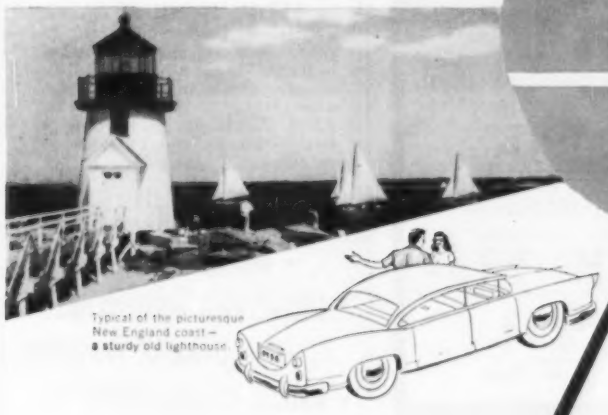

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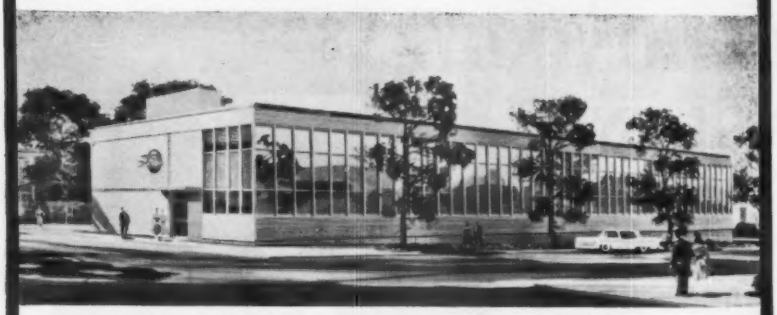

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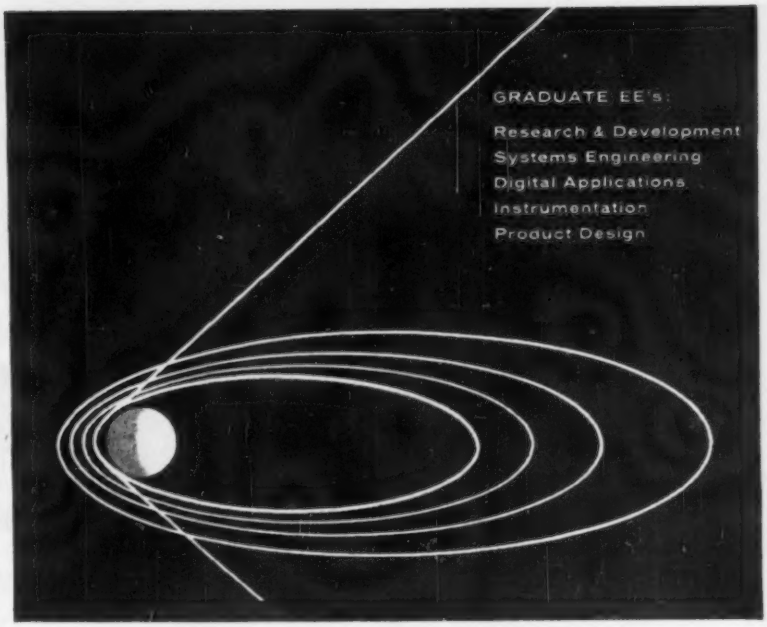

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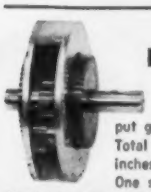

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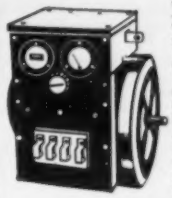

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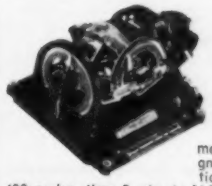

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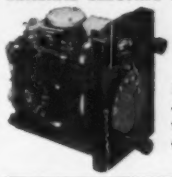

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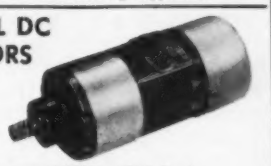

(approx. size overall 3¾" x 1¼" dia.:)

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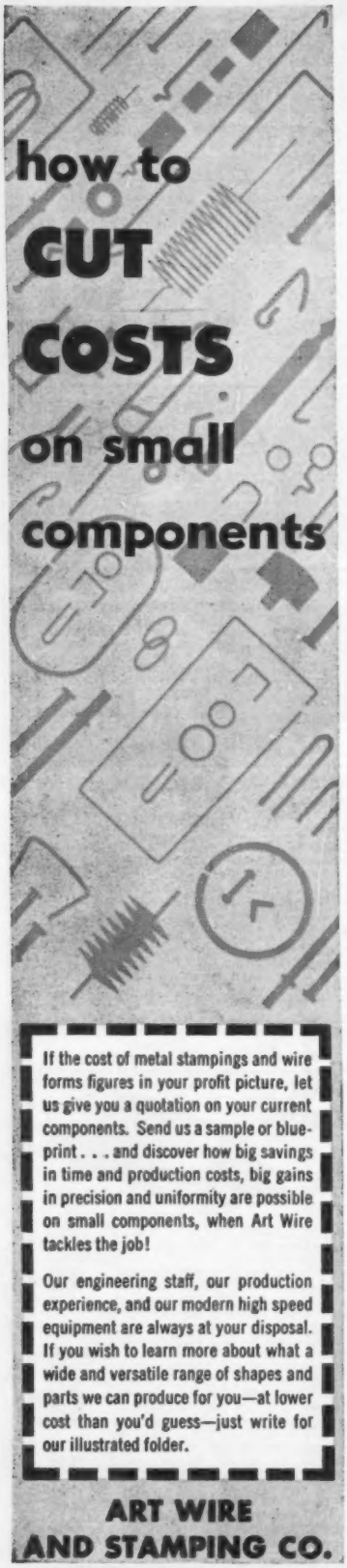
806069 Oster series reversible 1/50 h.p. 10,000 rpm. 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-8-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-25 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	4.00



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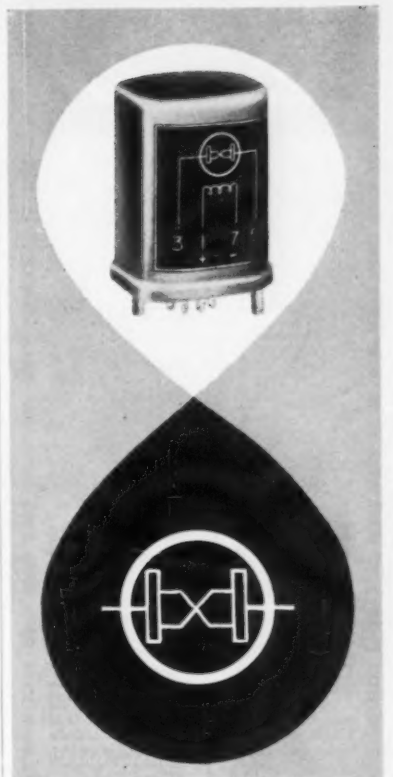

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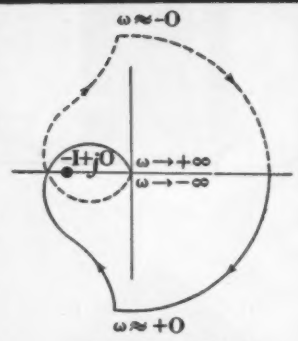

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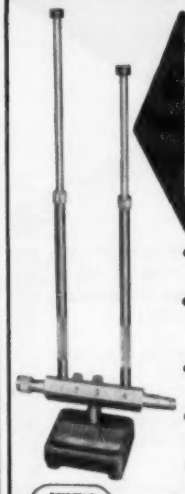

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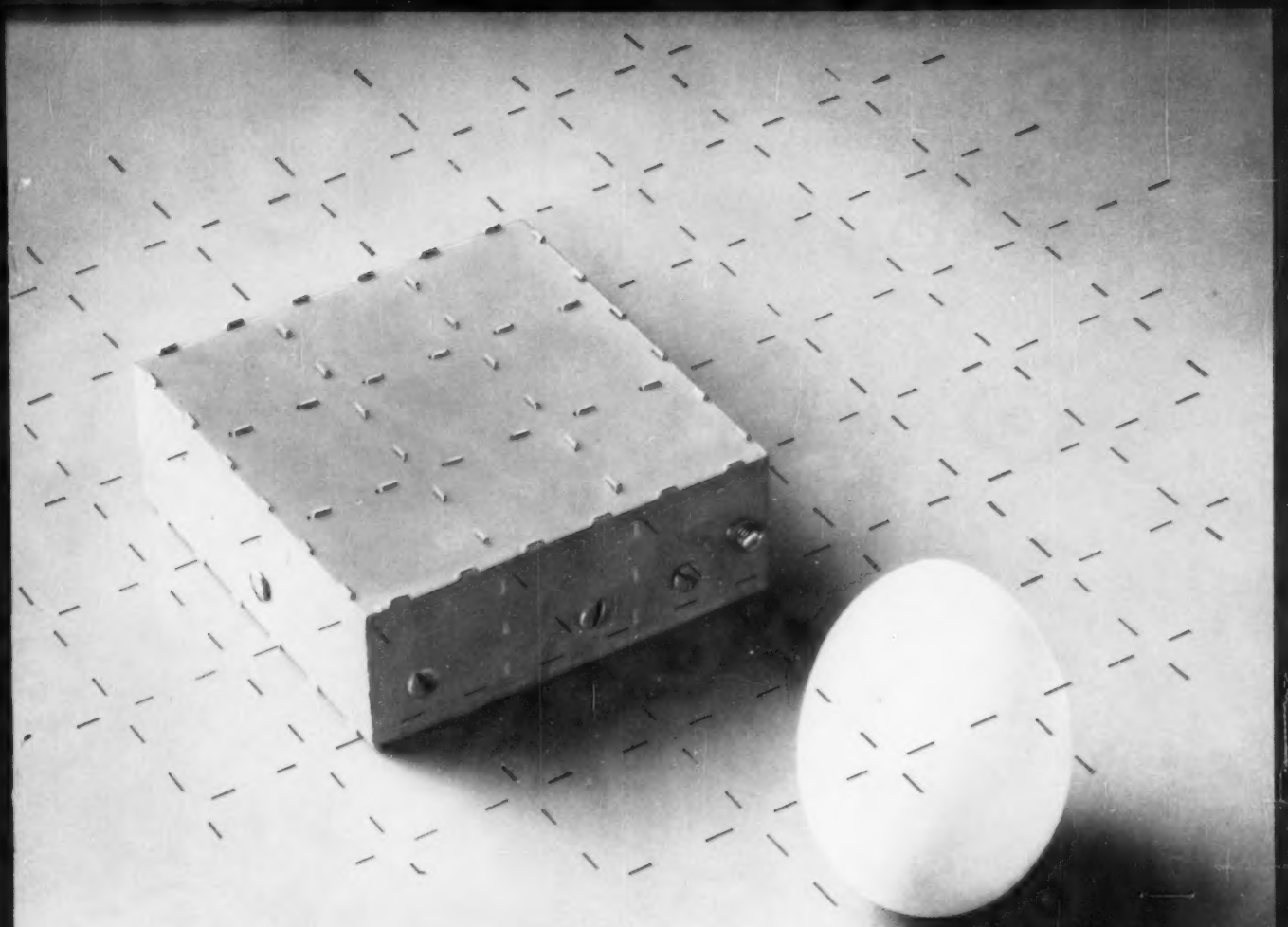

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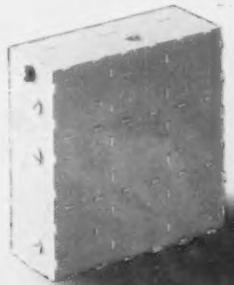

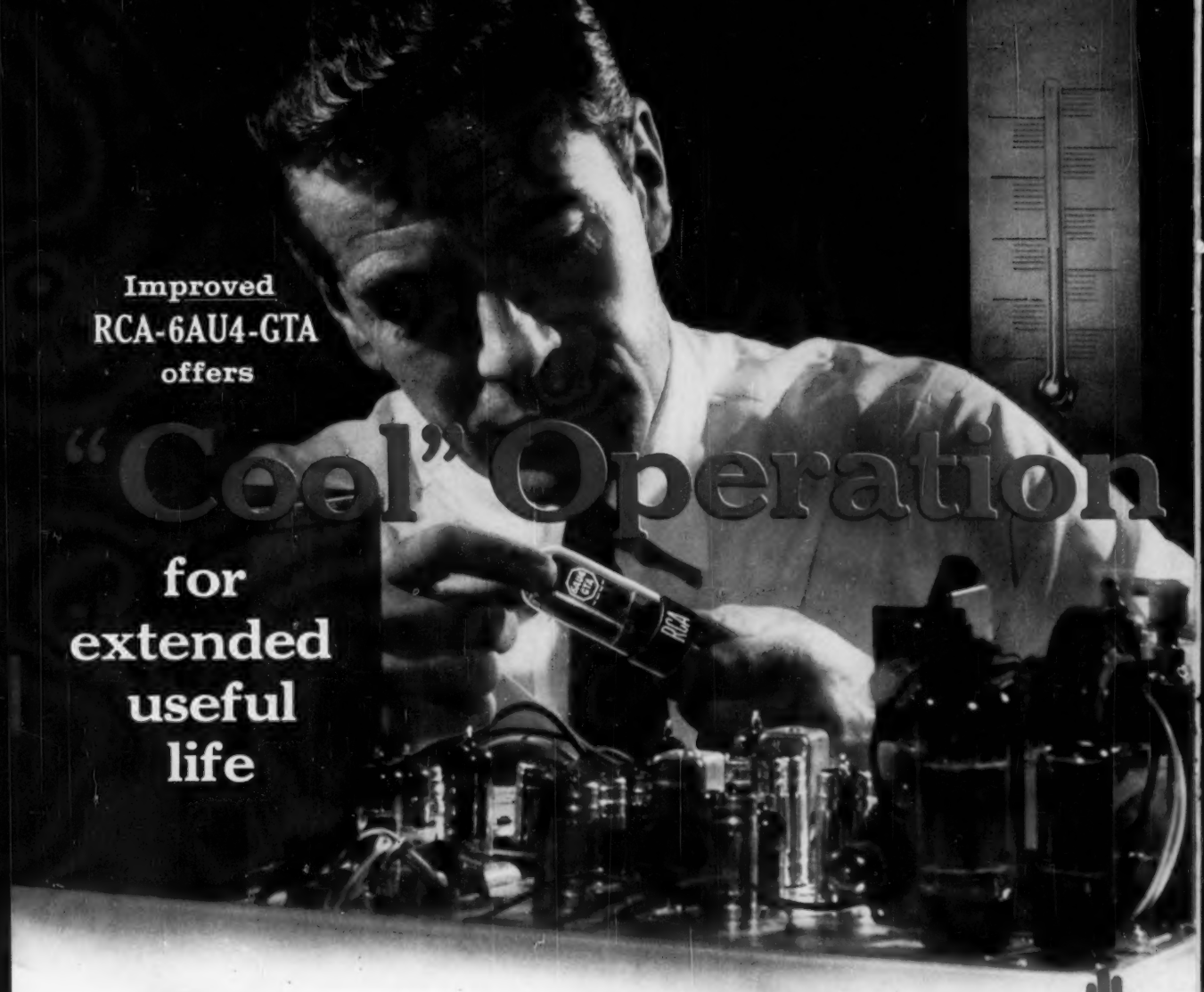

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